Papua New Guinea Smallholder Agriculture Development Project

'Effluent Study'

25 July 2011

Commissioned by the World Bank

J Barrett, Hebee Ltd.

The help and cooperation of OPIC (especially John Hulo), NBPOL and HOPL and the oil palm company staff is appreciated – report author

Foreward

In 2007, the World Bank approved an IDA Specific Investment Credit (IDA Credit 43740-PNG) of US$27.5 million equivalent for the Papua New Guinea (PNG) Smallholder Agriculture Development Project (SADP), which aims to improve community participation in local development while increasing revenue flow from the already established local oil palm production industry. The SADP has three components: (a) smallholder productivity enhancement including: the infill planting of new smallholder village oil palm along existing access roads; upgrading of provincial access roads and establishment of sustainable financing for road maintenance; and strengthening of oil palm extension services; (b) local governance and community participation, which supports the improved provision of local services and infrastructure through participatory processes; and (c) Project management and institutional support for Oil Palm Industry Corporation (OPIC), the implementing agency; and for the smallholder sector, through training, research and studies. The Project was approved by the World Bank's Board in December 2007, however the main Project activities (including road reconstruction and maintenance and infill planting) will only commence in 2011 due to delays in signing the Credit, establishing management capacity, and starting up implementation.

This report was undertaken to supplement information in the Environmental Assessment1 prepared for the SADP. Based on site visits and data analysis of the nine existing palm oil mills in the Project areas in Oro and West New Britain, the report assesses the environmental management implications of increased palm oil mill effluent (POME) production arising from the SADP. The report concludes that most of the mills in the SADP project area are legally compliant with Papua New Guinea national regulations. The author states that a categorical statement about full legal compliance for all mills is not made because of a lack of clarity with some of the permits and because all environmental performance data were not available (notably from the Oro sites). At the same time, the report highlights the importance of updating the PNG Environmental Code of Practice for the Oil Palm Processing Industry in order to strengthen national regulations and improve environmental monitoring. The study also points out discrepancies between the World Bank Group Environmental Health and Safety Standards for Vegetable Oil Processing (2007) and existing national regulations and a number of specific operational issues that need to be further investigated and addressed at different mills in the Project area.

While the study findings indicate that the relevant milling companies should have the processes and structures to adequately deal with additional wastewater production from the Project, it is Bank Management's view that the study is not fully conclusive. Further in-depth technical analysis of each mill's capability to treat liquid waste is needed in order to facilitate a more comprehensive analysis of current operations. The action plan attached here has been prepared to follow-up on the issues that have been raised in the SADP effluent study and ensure adequate mitigation measures are in place to deal with increased palm oil mill effluent due to the

[1] Douglas Environmental Services. 2007. Smallholder Agriculture Development Project –Environmental Assessment.

Project. This action plan will be jointly implemented by the Project implementing agency, the Oil Palm Industry Corporation (OPIC), the Department of Environmental and Conservation (DEC), New Britain Palm Oil Ltd., Hargy Oil Palm Ltd, and Kula Oil Palms Ltd, with the assistance of the World Bank. The milling companies, whilst fully endorsing and committing to the action plan, have concerns over the objectivity of the main report; the milling companies support the Bank Management's wish for further technical analysis.

PNG Smallholder Agriculture Development Project (SADP)
Palm Oil Mill Effluent (POME) Management
Agreed Action Plan

Item	Action	Target Completion Date	Responsibility
1	Obtain commitment in writing from the project area milling companies to: (i) establish baseline information for each project area mill, and (ii) conduct one follow-up environmental audit of these mills. Depending on the results of the follow-up audit and the perceived efficacy of the concurrent RSPO surveillance audits, additional follow-up audits will be considered. The baseline information for each project area mill will be established by: (i) Determining whether or not the mill is currently under compliance with the selected wastewater discharge criteria to surface water and land; (ii) Collecting and assessing the design and operating performance information for mill process wastewater treatment plants (WWTP) (generally effluent ponds but may include land application and secondary [polishing] treatment plants) at each project area mill; (iii) Projecting the increase in mill capacity utilization of the fresh fruit bunches (FFB) generated from the subject SADP and milling company's business expansion, and assessing the impacts on the mill and its WWTP as well as the quality of the mill's final effluent; (iv) Predicting the compliance of the final effluent with the selected discharge criteria as well as the impacts on the receptor (e.g. surface water); (v) Identifying the specific mitigation measures to bring the effluent into compliance with the selected discharge criteria and potential adverse environmental and human health impacts; (vi) Recommending an implementation schedule for each of the mitigation measures, and seeking agreement with the milling company on the implementation schedule; and (vii) Reporting the established baseline information.[2]	Commitment has been obtained from milling companies	DEC will be responsible for supervision of qualified consultants to establish the baseline information and undertake the audit as part of the SADP Environmental and Social Audit consultancy. The consultancy will be funded under the SADP Project and the SADP Project Coordinator would oversee procurement and financial management

[2] If the baseline audit report is viewed as containing any commercially confidential information relating to a manufacturing or industrial process or trade secret used in carrying on or operating any particular undertaking or equipment or information of the milling companies, or of a financial nature, this information may be excluded from the publicly disclosed baseline audit report provided there is a determination by the PNG Department of Environment and Conservation (DEC) that the information is confidential, and said determination is consistent with the World Bank policy on Access to Information.

	The follow-up environmental audit will include: (i) Reviewing the compliance of palm oil mill effluent with the existing discharge standards as per the Environmental Code of Practice Papua New Guinea Oil Palm Processing Industry and the "draft" updated standards once available; (ii) Monitoring the implementation progress of the mitigation measures; and (iii) Reporting the audit findings.[3] Use the results of the baseline information and the environmental audit to inform the World Bank (WB) management, Oil Palm Industry Corporation (OPIC), the SADP Project Steering Committee, and the Government (Department of National Planning and Monitoring (DNPM), and Department of Environment and Conservation (DEC)) on what the real risks are for the project (in contrast to the perceived risks) and the assessed efficacy of the Company mitigation programs.	Initiate actions by August 30, 2011 March 31, 2012 (Baseline completion)	DEC and representatives of the milling companies WB and DEC
2	Undertake specific measures at the following mills that have been identified to present high environmental risks: (i) Sangara Mill owned by Kula Palm Oil, (ii) Hargy and Navo Mills owned by Hargy Oil Palm Ltd., and (iii) Mosa Mill owned by New Britain Palm Oil (NBPOL). The following actions will be taken: (i) <u>At Sangara Mill</u>: Obtain commitment in writing from Kula Palm Oil regarding the timetable for undertaking its investigation of POME treatment and site drainage. Progress will be assessed as part of the follow-up environmental audits. (ii) <u>At Hargy and Navo Mills</u>: Obtain commitment in writing from Hargy Oil Palm Ltd. regarding the timetable for implementing actions to improve pond performance. Progress will be assessed as part of the follow-up environmental audit. (iii) <u>At the Mosa Mill</u>: Obtain commitment in writing from New Britain Palm Oil (NBPOL) for undertaking an investigation regarding cooling pond overflows into discharge channels and implementing relevant mitigation measures according to an agreed-upon schedule. Progress will be assessed as part of the follow-up environmental audit.	Commitment has been obtained from milling companies	OPIC

[3] If the follow-up audit report is viewed as containing any commercially confidential information relating to a manufacturing or industrial process or trade secret used in carrying on or operating any particular undertaking or equipment or information of the milling companies, or of a financial nature, this information may be excluded from the publicly disclosed audit report provided there is a determination by the PNG Department of Environment and Conservation (DEC) that the information is confidential, and said determination is consistent with the World Bank policy on Access to Information.

3	Assist Government (DEC) and industry to produce an updated Draft PNG Code of Practice for the Palm Oil [*Processing*] Industry, which will be used as the basis for regulation, to improve the quality and scope of effluent-related environmental monitoring, provide greater guidance on the design and operation of palm oil wastewater treatment systems in PNG, and better define “targets” and “limits” for discharge of treated palm oil wastewater to surface waters and land. In particular, the following will be established: (i) “draft” updated standards for palm oil wastewater discharge to surface waters and land, and (ii) the associated monitoring (sampling or split-sampling, sample preservation and chain-of-custody, analytical methods with quality assurance/quality procedures), recordkeeping, and reporting requirements to the Department and Environment Conservation (DEC). The “draft” updated discharge standards and monitoring and other requirements will be based on the PNG Environmental Code and draw on other international standards including WHO guidelines and the WBG EHS guidelines. SADP includes provisions for technical assistance/studies on sector issues through which DEC can be supported	Initiate actions by September 30, 2011	DEC, representatives of the milling companies and WB

Executive Summary

The purpose of this Effluent Study is to supplement information in the Environmental Assessment prepared for the Smallholder Agriculture Development Project (SADP)[4]. It has been commissioned by the World Bank to exercise its due diligence policies and in response to concerns expressed about the environmental management implications of increased palm oil mill effluent (POME) production arising from the SADP[5].

The Study objective given in the Terms of Reference is:

> *'to determine whether the palm oil milling companies in the SADP project areas have the capacity in their mills to adequately treat the increase in Palm Oil Mill Effluent (POME) anticipated due to an increase in production of Fresh Fruit Bunches (FFB) under the SADP'.*

The SADP will increase Fresh Fruit Bunch (FFB) production by three means: infill planting, improved supply by funding improvements in road infrastructure and promoting higher FFB yield from blocks through funding agricultural extension services.

All FFB milling is controlled and managed by two private companies that currently operate as three commercial ventures: New Britain Palm Oil (NBPOL), Hargy Oil Palm Ltd. (HOPL) and Kula Palm Oil (trading as Higaturu Oil Palm and largely owned by NBPOL). These companies will have the responsibility for the effluent produced from milling FFB arising from the SADP. It is estimated that by 2015, the POME resulting from milling SADP FFB will form 8% of the total effluent produced by 11 mills in the three project areas – Hoskins (NBPOL), Bialla (HOPL) and Oro (HOP). This is estimated to be some 182,000t of raw POME per year.

Management and treatment

Given the characteristics of POME if not properly managed it can have a series of significant environmental impacts affecting water quality, modifying watercourses and impacting soils and vegetation. But also given its composition when treated it can be used as a source of nutrients. This might be by direct application to land or mixing with empty fruit bunches (EFB) to make compost. In addition to direct impacts, there are indirect impacts associated with odour and emissions of greenhouse gases. Methane production from POME treatment is unavoidable. NBPOL is being proactive and has committed to five methane recovery projects that should not only provide energy substitution for its own operations but also provide electricity to surrounding communities. HOPL is also in the process of working towards methane recovery at Barema mill and is also considering methane recovery at its other mills. Despite the possible opportunities for using POME, it is still a large end of process waste stream requiring management.

4 Project Appraisal Document on a Proposed Credit for the Independent State of Papua New Guinea - Report No: 38558
5 World Bank Management Response to request for Inspection Panel Review of the Papua New Guinea Smallholder Agriculture Development Project (IDA 43740-PNG)

All mills use ponds for POME treatment. The term 'pond' is somewhat imprecise as it implies a treatment system of low complexity. This is true mechanically but not in terms of the biological reactions taking place. A summary of POME management at the respective mills is shown in Table 1.

Table 1
Summary of approaches to POME management

Mill	Operator	Commissioned	POME management
Mosa	NBPOL	1972	Treatment for discharge to surface water. Plans for methane recovery pond
Kumbango	NBPOL	1981	Treatment for discharge to surface water Plans for methane recovery pond
Kapiura	NBPOL	1990	Treatment for discharge to surface water Plans for methane recovery pond
Numundo	NBPOL	2001	Split treatment - discharge to surface water, and a proportion used for EFB composting. Plans for methane recovery pond
Waraston	NBPOL	2011	Treatment for discharge to surface water Plans for methane recovery pond
Hargy	HOPL	1970s	Treatment for discharge to sea Plans for methane recovery pond
Navo	HOPL	2002	Split treatment for EFB composting & excess for discharge to land Plans for methane recovery pond Composting to be abandoned
Barema	HOPL	2012	Treatment for discharge to surface water Plans for methane recovery pond
Sangara	HOP	1980	Treatment & discharge to land at this time. Future intention is to add a methane recovery pond.
Sumbaripa	HOP	2007	Treatment & discharge to land Future intention is to add a methane recovery pond.
Mamba	HOP	2008	Treatment & discharge to land for fertiliser replacement.

In recent history the approach to POME has changed from being viewed as a waste to be disposed of, to becoming part of business revenue. This has been driven by regulation, commercial opportunity, management tools and voluntary initiatives by the companies. Significant progress in fostering and implementing change has been aided by the adoption of both ISO 14001 and RSPO principles and criteria. All the mills in New Britain are certified to these standards and it is stated that operations in Oro will be certified following the take over by NBPOL. Certification should mean that systems are in place to ensure POME management complies with legal requirements through the adoption of best practices. Where it does not, companies run the risk of loosing their certified status following annual third party audits. Given that producers in Papua New Guinea seek to distinguish their product in the marketplace on the basis of its sustainability, loss of RSPO certification would be a serious matter.

In the past the Department for Environment and Conservation (DEC) has driven improved POME management practices where there has been gross pollution. However national regulation is not robust so the effective privatisation of regulation through third party certification is a positive initiative which should ensure POME management consistent with World Bank policies. Although some community based stakeholders have reservations about the impartiality of third party certification, as it is the companies that ultimately pay for the audits.

The study showed that most if not all mills are legally compliant. A categorical statement about full legal compliance for all mills is not made because the issuing of permits is going through a transitional phase (regulation under one Act of Parliament instead of three[6]), permits are not always clear, and environmental performance data were not always available (notably from Oro sites). In addition there are issues concerning data quality – selected comparison between internal monitoring results and analyses made by the National Analytical Laboratory show marked differences[7].

The modern mills are more readily equipped to manage POME with minimal environmental risk given their design, location and available space. Mosa, Hargy and Sangara mills present a greater environmental risk; Mosa due to the proximity of the ponds to a river; Hargy because of its low lying status, proximity to the sea and space constraints and Sangara because of its history, the characteristics of the site and its treatment system. A number of operational issues were identified during site visits for this study; with appropriate attention and technical consideration these can be addressed. ISO 14001 has a training and competency element which ought to ensure the number of such issues is minimised in the future. NBPOL is taking a positive step to enhance its technical pond management capabilities by employing a pond specialist.

Health issues

The study terms of reference request that current and historic health issues associated with POME are investigated. On the basis of the work completed and the current effluent management infrastructure, there is no reason to believe that any health issues can be attributed to current operations. Historically it is possible that poorly controlled effluent releases from the Sangara Mill did impact on the River Ambogo and thus potentially on the well-being of the local community. These releases would have added to other factors such as: inadequate community sanitation, inadequate waste management infrastructure, effluent from a nearby timber mill and potential impacts associated with plantations. Many of these factors remain or are being compounded by an increase in local population.

[6] A transition phase is being used by the Department of Environment and Conservation to accommodate for departmental resource constraints.
[7] This might be explained in part by sample transportation issues between mill sites and national laboratory in Lae. For example this might lead to a consistent over recording of 5 day Biochemical Oxygen Demand.

Conclusion

The Effluent study terms of reference asked if the palm oil milling companies in the SADP project areas have the capacity in their mills to adequately treat the increase in POME anticipated due to the SADP. This study interprets 'capacity' as: sufficient infrastructure to manage and treat POME to adequate standards prior to final use or disposal; adequate sampling and monitoring to demonstrate treatment to these standards, and management practices, capability and controls to ensure adequate environmental performance.

Study preparation has shown that: some sites have experienced operational issues that have influenced discharge performance; there are challenges with the quality of regulatory monitoring data and that the definition of full-compliance could be more precise. However given that all the mills are or will shortly be certified to ISO 14001 and RSPO principles and criteria, which have commitments for continuous improvement, the necessary practices, capabilities and controls should be in place to treat the increase in POME due to the SADP.

To give the World Bank the necessary assurance that the SADP POME is adequately managed (and that adequate management is more precisely defined) the following is recommended:

(i) The industry uses the proposed updating of the PNG Environmental Code of Practice for the Oil Palm Processing Industry as a means to; improve the quality and scope of effluent related environmental monitoring, provide greater guidance on the design and operation of POME treatment systems, and give more definition to 'targets' and 'limits' for discharge of treated POME to land and surface waters. This might include: establishing accepted monitoring frequencies, defining full-compliance to standard (i.e. strict adherence to limit values or assessment on a percentile basis to allow for abnormal circumstances), developing pragmatic limits for discharges to water (terrestrial & marine) for oil and grease and total suspended solids, and determining guidance and limits for the application of pond sludge to land and nutrient discharge to the aquatic environment.

It is recommended that the participatory approach between the industry and DEC in updating Environmental Code is continued and that the current informal relationship between the Code and government regulation is formalised. This should help accommodate resource constraints experienced by DEC and help overcome the challenges associated with monitoring data.

(ii) HOPL issues and implements an improvement plan which documents mill effluent management practices that includes; results from the study examining the potential impact of POME discharges on the Bismark Sea, describes the actions to improve pond performance at the Hargy Mill, and describes planned changes to POME treatment and management at the Navo Mill.

(iii) HOP makes a thorough investigation of the POME treatment and site drainage at Sangara mill. The objective will be to obtain greater understanding of the system, more readily respond to accusations that mill effluent has deleterious environmental impacts, reduce the volume of water in the gully ponds, and ensure adequate environmental performance. As part of the review process for this study, HOP has committed to a thorough investigation as part of its continuous improvement plan for the operation.

EKSEKETIV SAMARI
HET TOK IGO PAS

As tingting long dispela wok painim aut long ol pipia wara blong fektori (Effluent Study) em long halivim ol arapela tok klia long pasin blong skelim enviromen (Environment Assessment) long Smallholder Agriculture Development Project (SADP)[8]. Dispela tok orait World Bank i givim long bihainim polisi blong em na harim ol wari, ol man meri i tokaut long lukaut blong enviromen we ol mak blong rausim pipia long ol fektori blong kukim wel pam, ikamap aninit long SADP[9] wok.
As tingting long tok orait long wokim dispela wok painim aut (Terms of Reference);

> *'long painim aut sapos ol wel pam kampani insait long projek eria blong SADP igat inap save na wei blong oli mekim kamapim pasin blong daunim hevi ikamap long niupela mak blong pipia wara (POME) sapos mak blong wel pam prut bans igo antap moa aninit long SADP'*

SADP bai givim sapot long apim mak blong prodaksen long wel pam prut bans long tripela wei:

1. long planim nupela wel pam insaet long ol spes namel long ol blok (infill planting),
2. stretim ol rot, na tu;
3. halivim long apim ol hevi na namba blong ol wel pam bans insaet long ol gutpela wok didiman (Extension Service).

Tupela bikpela kampani i papa na lukautim olgeta fektori blong kukim wel pam prut. Tupela i wok aninit long tripela bisinis nem. NBPOL, HOPL na Kula Palm Oil (em i wok olsem Higaturu Oil Palm tasol NBPOL i papa long em nau). Dispela ol kampani oli gat bikpela wok long lukautim ol pipia wara (effluent) ikam long ol fektori blong kukim wel pam prut aninit long SADP. Oli ting olsem long yia 2015, pipia wara blong fektori (POME) ikam long ol wel pam prut aninit long SADP bai kamapim 8 % olgeta long ilewen (11) pela fektori long tripela projek eria – Hoskins (NBPOL), Bialla (HOPL) na Oro (HOP). Ol i ting olsem bai i kamapim 182,000 tons, hevi blong ol pipia wara (POME) ikam long ol fektori insaet long wanwan yia.

Menesmen Na Pasin blong Lukaut

Sapos ino gat gutpela menesmen long ol pipia wara blong fektori, bai igat bikpela asua long enviromen, we em bai bagarapim wara, senisim ron blong ol wara na bagarapim ol graun na bus tu. Sapos igat gutpela menesmen, dispel pipia wara bai kamap olsem gutpela gris blong graun. Dispela bai putim stret igo long graun, o mixim wantaim emti prut bans na kamapim kompos. Igat tu ol arapela hevi ikam long ol arapela rot em olsem smel blong pipia wara wantaim ol simuk blong greenhaus ges. I gat wanpela kain ges oli kolim Miten (Methane) prodaksen we ikamap long pipia wara blong fektori (POME) em bai stap yet. Long ol luksave, NBPOL igat strongpela komitmen long wokim fopela

[8] Project Appraisal Document on a Proposed Credit for the Independent State of Papua New Guinea – Report No: 38558
[9] World Bank Management Response to request for Inspection Panel Review of the Papua New Guinea Smallholder Agriculture Development Project (IDA 43740-PNG)

rikavari projek we iken wokim pawa blong kampani na tu long saplai long ol komuniti. Tasol maski olgeta luksave long ol niupela rot, wok blong gutpela pasin menesmen bai i mas stap olgeta taim. Olgeta fektori igat ol liklik raun wara blong sindaunim pipia wara (POME), inap sampela taim bihain we ol binatang blong graun bai kaikaim. Samari blong ol fektori wantaim menesmen blong pipia wara (POME) em soim long daubilo.

Table 1

Samari long ol pasin blong menesim pipia wara (POME) blong ol fektori

Fektori (Mill)	Husat i Papa (Operator)	Statim long wok (Commissioned)	Menesmen blong pipia wara (POME Management)
Mosa	NBPOL	1972	Treatment for discharge to surface water Plans for Methane recovery pond
Kumbango	NBPOL	1981	Treatment of discharge to surface water Plans for Methane recovery pond
Kapiura	NBPOL	1990	Treatment of discharge to surface water Plans for Methane recovery pond
Numundo	NBPOL	2001	Split treatment – discharge to surface water, and a proportion used for EFB composting.
Waraston	NBPOL	2011	Treatment of discharge to surface water Plans for Methane recovery pond
Hargy	HOPL	1970s	Treatment for discharge to sea
Navo	HOPL	2002	Split treatment for EFB composting & access for discharge to land
Barema	HOPL	2012	Treatment to discharge to surface water
Sangara	HOP	1980	Treatment & discharge to land for disposal
Sumbaripa	HOP	2007	Treatment & discharge to land for disposal[a].
Mamba	HOP	2008	Treatment & discharge to land for disposal[a].

a – pond configuration suggests treatment could be to surface water discharge standards

Long taim bipo dispela pasin blong menesmen long pipia wara (POME Management) i senis long pasin blong rausin, tasol nau ikamap olsem wanpela hanwok blong ol kampani. Dispela ibin kamap long ol kainkain lo, bisnis opotuniti, ol pasin blong menesmen na save blong wanwan man-meri. Igat bikpela senis ikamap we tupela lo em long ISO 14001 na RSPO bai banisim wok blong ol kamapani long gutpela wei. Olgeta fektori insaet long Niu Briten i wok aninit long dispela lo, na tu ol fektori insaet long Oro bai kam aninit long wankain lo na pasin taim NBPOL ipapa long ol dispela wok. Sapos kampani ino bihainim lo bai inogat luksave na dispela emi ken kamapim nem nogut blong kampani, long wanem Papua New Guinea ilaik kamapim gut nem long ol prodak blong oil pam.

Long sampela taim igo pinis Dipatmen blong Enviromen na Konsavesen ibin go pas long ol pasin blong gutpela menesmen long pipia wara, we ibin bagarapim ol ples na wara tu. Tasol dispel mama lo ino bin wok gut tumas olsem na pasin blong givim dispel wok igo long ol kampanai yet emi mo gut long wanem pasin blong menesmen long pipia wara i mas bihainim tu polosi o lo blong World Bank. Ibin gat sampela asikim ikam long ol komuniti long wanem ol namel man we kampani ibaem ol na wok ol dispela wok certification.

Dispela wok painim aut i soim olsem olgeta kampani husat ipapa long ol fektori i bihainim lo. Pasin blong givim ol pemit iwok long senis long kamap wanpela Act tasol long Palimen na ino tripela[10], na tu ol pemit inosave kamap klia na ino gat ol enviromen data. Igat sampela asua long ol kualiti blong ol dispela data tu. Ol lain blong glasim data long wok ples ino wankain olsem ol glasim long ol National Analytical Labrotary[11].

Ol nupela kain fektori nau igat sampela masin blong menesim gut ol pipia wara na daunim hevi long ol enviromen, wantaim ol gutpela disain, lokesen na spes. Mosa, Hargy na Sangara fektori ikamap olsem bikpela hevi liklik long wanem; Mosa - ol raun wara blong pipia iklostu tumas long wara i ron; Hargy - long wanem emi stap daubilo tumas klostu long solwara na tu ino gat inap spes na long Sangara em stap daunbilo tumas na tu long ol kainkain menesmen long bipo. Dispela wok painim aut ibin painim sampela hevi taim ol ibin wokabaut; wantaim gutpela save na pasin blong skelim wok ol inap daunimn ol hevi. ISO 14001 igat skul blong lainim wei blong daunim ol hevi long bihain taim. NBPOL i wok long lukluk long painim wanpela saveman long menesmen long ol pipia wara, dispela bai strongim save na gutpela pasin blong daunim ol hevi.

Ol Kainkain Sik

Tokaut blong dispela wok painim aut (Terms of Reference) i bin lukluk tu long ol nupela na olpela kainkain sik ikamap namel long ol man-meri we pipia wara ikamapim. Aninit long dispela wok painim aut na tu pasin blong menesmen, i soim olsem inogat kainkain sik ikamap. Long bipo i tru olsem pasin blong menesmen long ol pipia wara long Sangara inobin gutpela tumas, na ibin gat planti hevi i kamap long ol ples klostu. Ino bin gat gutpela ples blong man-meri tromoi pipia blong ol, menesmen blong pipia wara ino bin gutpela, ibin gat tu ol pipia blong wanpela somil klostu long Ambogo na ol dispel ikamapim ol hevi long planti man-meri.

Las Tok

Tokaut blong dispel wok painim aut (Terms of Reference) i bin asikim sapos ol wel pam kampani insaet long SADP projek eria igat kapasiti long ol factori blong ol long lukautim gut mak blong menesim ol pipia wara sapos SADP ikamapim bikpela mak mo long ol pipia wara. Dispela wok painim aut emi luksave olsem kapasiti emi toktok long pasin blong bihainim gut mak aninit long lo blong rausim o yusim pipia wara, igat inap sempel blong glasim, na tu lukluk behainim ol pasin blong kamap long ol mak blong wok menesmen, save na lukaut blong ol wok kamap blong enviromen.

Rere blong dispela wok painim aut isoim olsem sampela pasin blong wok i as blong ol hevi we i kamapim ol kainkain pasin blong rausim ol pipia wara; igat tu bai I gat planti wok moa yet long gutpela kualiti na passim blong glasim ol data ikamap wankain olsem lo i tok. Nau i luk olsem olgeta fektori bai i kam aninit long lo blong ISO 14001 na RSPO, we isoim komitmen blong kamapim gutpela wok moa

[10] The transition phase is a method used by the Department of Environment and Conservation to accommodate for departmental resource constraints

[11] This might be explained in part by sample transportation issues between mill sites and national laboratory in Lae. For example this might lead to a consistent over recording of 5 day Biochemical Oxygen Demand.

yet, ol gutpela pasin blong wok, save na passin blong lukaut imas stap rere long ol mak blong pipia wara taim i go antap aninit long SADP.
Long bihainim lo na tokstret long World Bank olsem pipia wara blong SADP is stap long gutpela menesmen, i gutpela long skelim gut ol dispela tingting.

(i) Wel pam indastri imas bihainim nupela PNG Environmental Code of Practice for Oil Palm Processing Industry olsem wei blong; apim kualiti na pasin blong monitarim pipia wara wantaim enviromen, gutpela wok lukaut long ol disain na pasin blong lukautim ol pipia wara long noken aburusim mak bipo long ol igo ausaet long graun na ol wara tu. Dispela bai karamapim ol taem blong wokim ol monitaring wok, strongpela lo long bihainim stret ol mak blong ol gris na wel bipo igo long ol wara i ron long bus na solwara tu, ol mak blong ol pipia wara we kampani i putim long graun na gris igo long ol ples blong wara.

Igat rekomendesen olsem bai i mas gat wok bung wantaim namel long indastri na DEC long updatim Environmental Code igo het na dispel pasin blong wok poroman namel long Code na gavaman lo imas kamap lo. Dispela bai i halivim long daunim ol hevi blong wok we DEC i sot long ol risos bai oli monitarim ol data.

(ii) HOPL igivim wanpela pas long pasin blong menesim ol pipia wara ikam aut long fektori na i karamapim; ol wok painim aut na glasim ol pipia wara igo insaet long solowara blong Bismark, tok klia long wei blong impruvim wok blong ol raun wara blong ol pipia long Hargy fektori, na tu tok klia long ol senis blong pipia wara aninit long menesmen blong Navo fektori.

(iii) HOP imas mekim wok painim aut long ol pasin blong menesim pipia wara blong fektori na tu ol rot blong rausin pipia wara long Sangara fektori. As tingting em long kamapim gutpela luksave long system na rere long ol kainkain komplen ikam long ol man-meri, daunim mak blong wara long ol baret na gutpela wok enviromen. Aninit long dispela wok painim aut HOP igat komitmen long wokim wok painim aut long pasin blong impruvim plen blong ol wok.

Table of Contents

1. Introduction

The purpose of this Effluent Study is to supplement information in the Environmental Assessment prepared for the Smallholder Agriculture Development Project (SADP)[12]. It has been commissioned by the World Bank to exercise its due diligence policies and in response to concerns expressed about the environmental management implications of increased palm oil mill effluent (POME) production arising from the SADP [13].

The Study objective given in the Terms of Reference (dated 18 June) is:

'to determine whether the palm oil milling companies in the SADP project areas have the capacity in their mills to adequately treat the increase in Palm Oil Mill Effluent (POME) anticipated due to an increase in production of Fresh Fruit Bunches (FFB) under the SADP'.

Where:

- The palm oil milling companies are the New Britain Palm Oil Ltd., Hargy and Higaturu (a part of Kula Oil Palms Ltd) [14].
- SADP projects areas are in Oro (Northern Province), Hoskins and Bialla (both in West New Britain) – see Figure 1
- '*Capacity …. to adequately treat*' concerns: the provision and operation of mill processing and wastewater treatment infrastructure that will ensure it is managed in a manner that is legally compliant, consistent with World Bank policies and sustainable development principles [15].

The SADP project seeks to increase the income and improve livelihoods of smallholders already involved in oil palm production. Project implementation will increase smallholder Fresh Fruit Bunch (FFB) production in one of three ways:

- Increase in the area of smallholder oil palm up to 9,000ha in total for the three project areas in Oro, Hoskins and Bialla by infill planting.
- Improved FFB collection from existing oil palm blocks which currently have interrupted access or no access due to poor road conditions.
- Increase production per hectare by improving extension services leading to more regular fertiliser use, enhanced agricultural practices, and ensure improved and regulated crop pick up.

[12] Project Appraisal Document on a Proposed Credit for the Independent State of Papua New Guinea - Report No: 38558
[13] World Bank Management Response to request for Inspection Panel Review of the Papua New Guinea Smallholder Agriculture Development Project (IDA 43740-PNG)
[14] New Britain Palm Oil Ltd. (NBPOL) acquired an 80% stake in CTP (PNG) from CTP Holdings in February 2010 and named the business Kula Oil Palms Ltd.
[15] The application of sustainable development principles should ensure the concerns of local communities are accounted for.

Although the SADP was approved by the World Bank Board in December 2007, the main project activities have not yet commenced.

1.1 Structure of the business

All palm oil processing mills in PNG are privately owned and operated, with the largest operator being New Britain Palm Oil Ltd. (NBPOL). Mill ownership and associated milling capacity is shown in Table 1.

Table 1
Mill ownership and capacity

Company	SADP Project Area	Name of Mill	Location	Product	Mill Capacity *(t/FFB/hr)*
NBPOL	Hoskins	Mosa	WNB	CPO	60
NBPOL	Hoskins	Kumbango	WNB	CPO & PKO	60
NBPOL	Hoskins	Kapiura	WNB	CPO	60
NBPOL	Hoskins	Numundo	WNB	CPO	80
NBPOL	Hoskins	Waraston [a]	WNB	CPO	60
HOPL	Bialla	Hargy	WNB	CPO & PKO	45
HOPL	Bialla	Navo	WNB	CPO & PKO	45
HOPL	Bialla	Barema [a]	WNB	CPO & PKO	45
HOP	Oro	Sangara	NP	CPO	60[b]
HOP	Oro	Sumbaripa	NP	CPO	30[c]
HOP	Oro	Mamba	NP	CPO	25

[a] - to be commissioned in 2010/11, all the other mills were visited in completing this study

HOPL – Hargy Oil Palm Ltd. HOP – Higaturu Oil Palm

CPO – crude palm oil, PKO palm kernel oil, WNB – West New Britain, NP - Northern Province

b – designed for larger capacity but will be refurbished to 60t/hr

c – will be upgraded to 60/t/hr in 2011/2012

The aim of palm oil companies is to keep mills operating near capacity by ensuring a consistent supply of fruit to achieve commercial objectives. FFB is supplied to the mills from both smallholders (from customary land or land settlement schemes[16]) and from company plantations. Oil palms are continuously harvested throughout the year with peak harvesting typically between December and June. Smallholder FFB is collected from the nearest roadside by the palm oil companies (contractors or own vehicles) and subsequent transfer to a mill. This process should take place within a short space of time as the fruit deteriorates after harvesting - owing to a build-up of free fatty acids - diminishing the value of the final product (CPO) and reducing the efficiency of the milling process. Consequently FFB is rarely stockpiled at the mill.

[16] See SADP Social Impact Assessment for explanation of the different status of smallholders, for the purpose of this study these groups are referred to collectively as smallholders.

Plantation supply is under direct control of the palm oil companies; whereas supply from smallholders is influenced by: smallholder choices such as level of fertiliser application and approach to harvesting; the ability of the milling companies to make roadside collections, and the efficacy of the extension services provided by the government body the Oil Palm Industries Corporation (OPIC).

The Palm Oil company mills are the only market for smallholder FFB with respective smallholders falling into catchment areas around the mills. Mill catchments are governed by journey time, the associated costs (diesel, vehicles, labour) and operational need to match supply with milling capacity. The palm oil companies manage the logistics of supply.

Increases in the land area planted and yield increase are intrinsically linked to the development of new mills as planting palms without milling capacity and the ability to transport FFB to the mills and/or building a mill without a ready FFB supply is not commercially expedient. When planning new milling capacity, company planners have a firmer appreciation of the yields and anticipated supply from their own plantations than that from smallholders (where the number of variables influencing supply is far greater). Crop supply budgets are given to mill managers on an annual basis for operational planning, and five to 10 year projections are made for strategic planning. Strategic plans as they relate to new milling capacity are given in section 5.

1.2 SADP production

The Bank Project Appraisal Document estimates that implementation of the SADP will increase FFB production by a total of some 260,000 tonnes per annum across the three project areas. This will be realised by infill planting over a five-year period and enhanced productivity of 2.7t/ha arising from better access roads, increased fertiliser application and improved harvesting practices.

- The relative contribution of enhanced FFB production from the SADP compared to a 2005 baseline is shown in Table 2. The purpose of this table is to use accepted figures to illustrate the proportion of FFB production and subsequently effluent from milling (POME) attributable to the SADP. In practice these proportions Hoskins (13%), Bialla (16%) and Oro (29%) will be less, given the ongoing trend of increased company FFB production, and the time it will take for the additional SADP production to be realised. More current projections for FFB production are given in section 5. For example for Hoskins the proportion is 6% of estimated production in 2015.

Table 2
Plantation & smallholder production details by project scheme, 2005 [a]

	Hoskins	Bialla	Oro	Total
Plantation				
FFB production (t)	628,572	157,777	190,000	976,349
Smallholder				
Total hectares in production	20,289	9,977	9,216	39,482
FFB production (t)	323,211	143,369	132,607	599,187
FFB t/ ha in production	15.7	14.5	14.3	14.8
Total FFB produced	**951,783**	**301,146**	**322,607**	**1,575,536**
Additional area infilling (ha) [a]	3,500	1,240	4,000	8,740
SADP increase in FFB (t) [b]	120,000	48,000	93,000	260,000
SADP FFB (& POME) as a proportion of total	13%	16%	29%	17%

a – Project Appraisal Document (PAD) Tables A1.1 & A4.1

b - Smallholder hectares + infilling x (yield per ha + 2.7 t/ha [PAD note 50])

1.3 Study Approach

The study analyses the potential environmental impact of increased POME production from the SADP by:

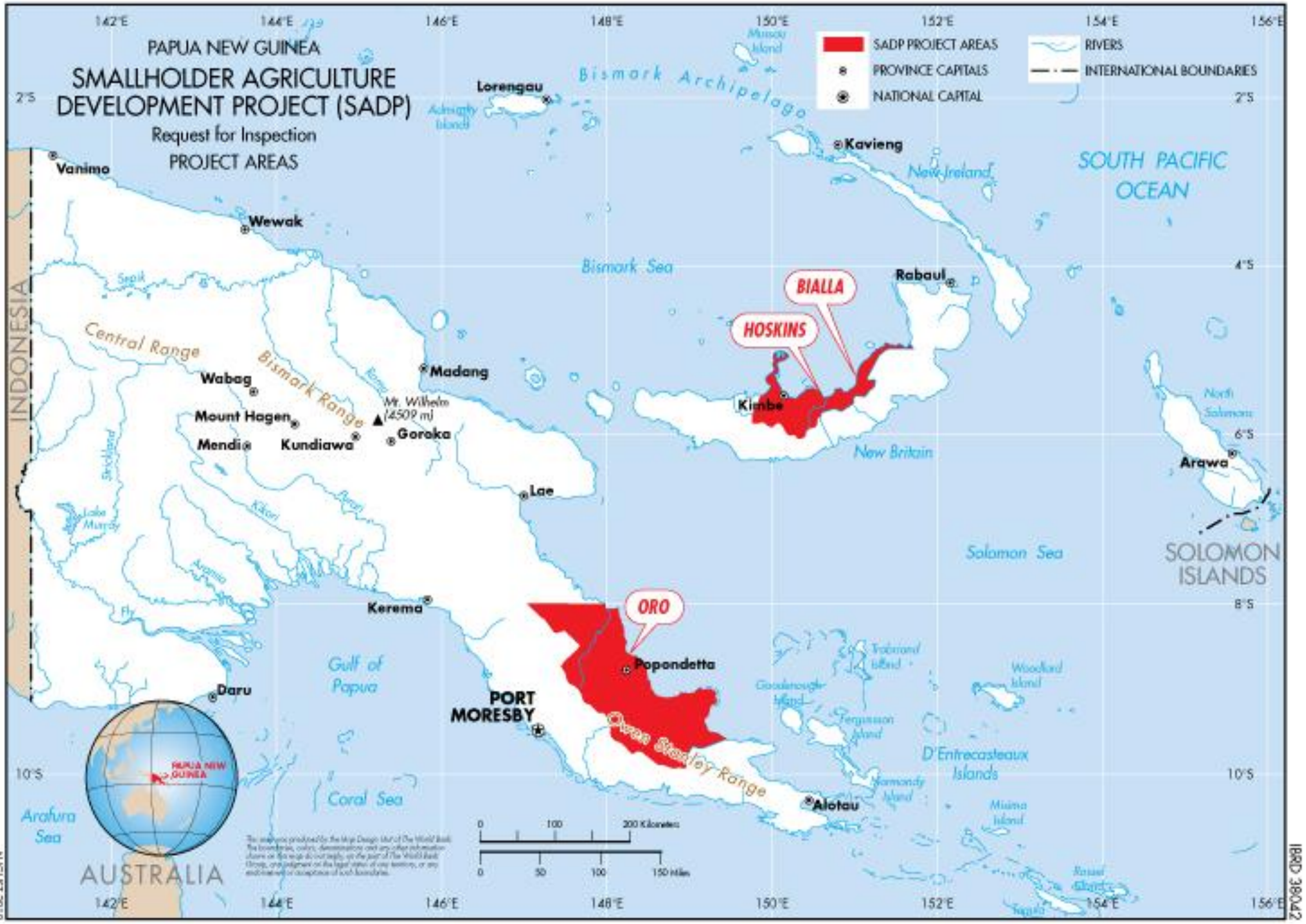
- Estimating additional POME production arising from the SADP.
- Outlining the process of POME production and identifying the environmental risks associated with POME.
- Identifying POME management options.
- Identifying who will be responsible for managing SADP POME and reviewing the safeguards to ensure this is adequate.
- Reviewing the environmental performance of the existing mills.

1.4 Study Details

This study was completed on the basis of terms of reference provided by the World Bank.

The study comprised: inspection of nine mill sites, consultation with SADP stakeholders and data collection over a 13 day period in July 2010 as well as document review and subsequent report preparation. A list of meetings and site visits is given in Appendix 1.

Figure 1
Smallholder Agriculture Development Project locations.



2.0 POME and POME treatment

This section gives an overview of the milling process, the factors influencing POME production and the methods for POME treatment and management. This is used as a basis for comment about specific mills in sections 5 and 6.

2.1 POME production

The traditional milling process is described below and shown in Figure 2. Comment is made about process modifications that can improve milling water management efficiency at the end of this sub-section.

Once FFB is received at a mill it passes through the following processes prior to storage and subsequent distribution for refining.

- Sterilisation. The objectives of this process are to deactivate lipolytic enzymes that lead to free fatty-acid formation, and to increase the efficiency of subsequent processes. This is traditionally a batch autoclave process that is estimated with good milling practices to produce some 0.15 – 0.2 tonnes[17],[18] of effluent (steriliser condensate) per tonne of processed FFB.

- Stripping, digestion and pressing. A rotary drum thresher is used to strip sterilised fruits from the bunch stalks. The empty fruit bunches (EFB) are typically transferred to plantation ground as raw fertilizer. Sterilised fruit is digested in a heated vessel (digester) at approximately 90^{O}C to loosen the mesocarp (fleshy part) from the nuts for subsequent pressing. The homogenous oil mash resulting from digestion is pushed through twin-screw presses, where the oil is separated from the spent mesocarp and nuts (press cake) before clarification. The press cake is sent for further processing (see depericarping below). Mixing water is typically added to assist the digestion and pressing processes.

- Clarification and drying. The oil stream from the presses contains varying amounts of water and impurities containing both soluble and insoluble vegetable matter. The aim of clarification is to separate oil from this matter. To improve clarification, hot water is added to the raw oil extracted from pressing. The conventional process for separating oil from water and suspended solids uses gravity-assisted separation in a clarification tank. The top phase (clarified oil) is continuously skimmed off for purification in high-speed centrifuges. The ‘bottom’ phase containing a mixture of water, oil and non-oily substances (NOS) is sent to a sludge separator for further oil recovery. This is amounts to some 0.625 tonnes per tonne of FFB.

- Sludge separator/centrifuge. The function of the sludge separators is to recover oil remaining in the clarifier sludge. During separator operation, sludge is fed to the centre

[17] Environmental Management Guideline for the Thai Palm Oil Industry.
[18] Environmental Code of Practice for PNG Oil Palm Processing Industry.

of the sludge separator bowl from where centrifugal forces drive water to the outside and the lighter phase oil flows towards the centre of the bowl. Oil is removed from the separators and returned to the clarifier for recovery. To improve oil separation it is common practice to add water to the bottom sludge which will become effluent. Sludge water is discharged to a sludge pit from where any free oil is skimmed off for recovery, the remaining sludge is pumped to effluent ponds.

- Decarping and kernel separation. Press cake made up of nuts and fibre passes along a cake breaker conveyor, before being fed to a separating column where light fibres are drawn by cyclone to a fibre conveyor. Heavier nuts and any other materials such as stones drop into the depericarper drum, which polishes the nuts and removes the stones. Nuts pass through a ripple mill where they are cracked. The cracked mixture (cracked/uncracked nuts, kernel & shell) is discharged to a cracked mixture conveyor onto a pneumatic winnowing system that separates kernels from the shell, dirt and other debris. The kernels pass to silos for drying and subsequent onsite kernel oil recovery or for export. In older mills a wet process was used to separate kernel and shell, this technology is not employed in PNG.

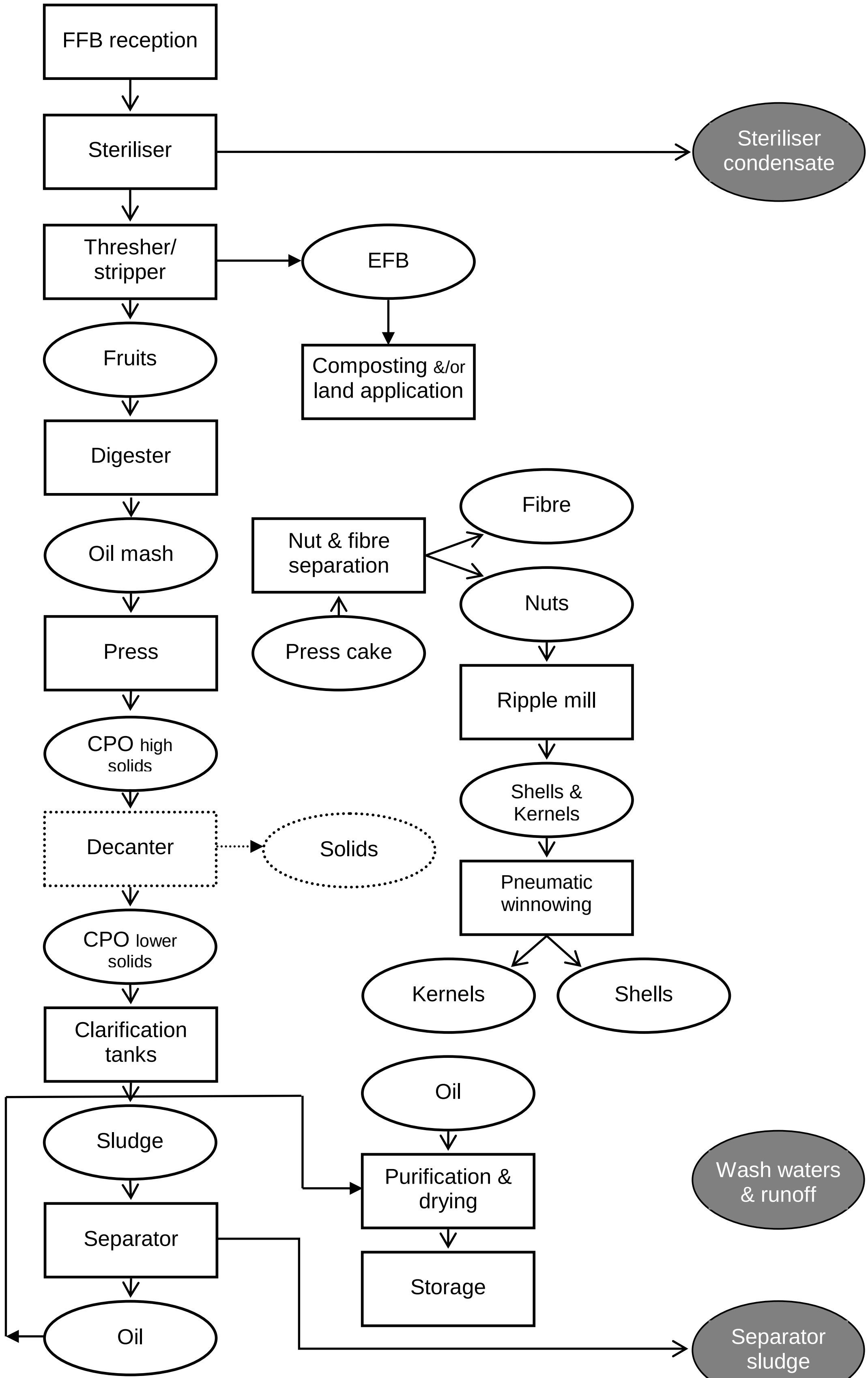
The traditional process described above is modified to increase the proportion of oil recovered, and to reduce water demand and subsequent POME production. These modifications include recycling steriliser condensate and changing the oil separation system.

Recycling and recovery of steriliser condensate. A further process stage that recovers residual oil from steriliser condensate can be employed where recovered condensate is fed into the main process and the overall volume of POME might be reduced some 10%. However, there are practical issues associated with this. When FFB quality is poor with a high concentration of FFA, recycling can lead to a build up of FFA in the process impacting upon CPO quality and subsequent sale price. In addition condensate recycling is said to have the risk of concentrating iron in the system. Some mill managers are not prepared to take these risks so do not practice condensate recycling, or divert this flow to the effluent stream when these conditions arise.

Oil separation. The conventional oil separation system using a combination of settling tank and underflow centrifuge has a low separation efficiency, impacts on oil quality owing to oxidation arising from long retention times and produces large volumes of POME from dilution water added to assist separation[19]. A more efficient alternative involves direct centrifuging of screened raw press oil. These decanting systems might be 2- or 3- phase. In a 3-phase decanter the liquid-liquid-solids mixture is separated into an oil phase, solids and wastewater. Whereas in a 2-phase system, this mixture is separated into clean oil and an NOS fruit water mix. As well as benefits gained from improved water efficiency (reducing demand for dilution water and POME

[19] Environmental Management Guideline of the Thai Palm Oil Industry.

Figure 2
The milling process



production by a suggested 40 – 60%), process times are reduced, the need for settling tanks is removed and there is improved energy efficiency[20].

2.2 Estimating POME production

Based on the FFB production figures given in Table 2, the additional annual POME arising from the SADP across the three projects areas will be 182,000t – Hoskins 83,500t, Bialla 33,800t and Oro 65,000t. In practice these figures will vary significantly owing to fluctuations in supply, technology employed, plant layout and management practices. This sub-section notes the factors influencing POME production to consider in planning approaches to POME management and in sizing the requisite facilities.

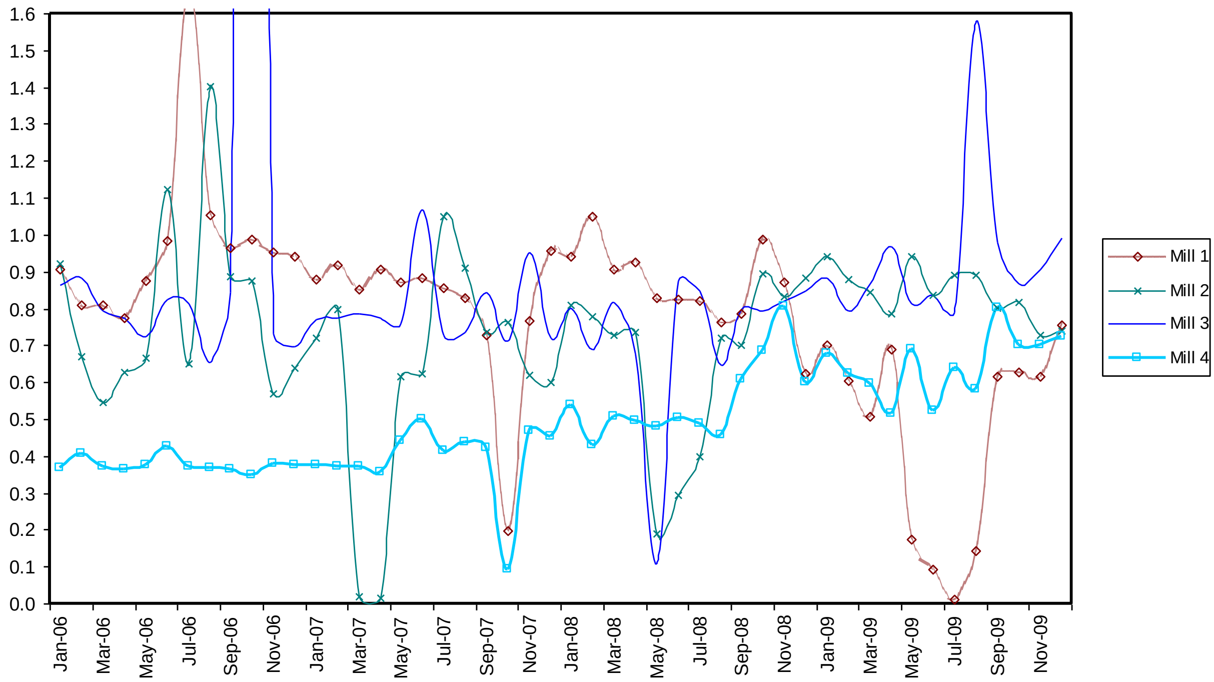
Many variables influence the volume and quality of POME produced. These fall into three main groups: supply (season, harvesting, transport, and holidays), design (mechanical equipment and drainage system) and operating practices (leaks, oil losses, and cleaning practices). POME treatment and handling facilities should be designed to accommodate seasonal peak FFB supply, have spare capacity to allow for abnormal process operations and where there is combined POME sufficient capacity to deal with storm water arising from periods of maximum rainfall.

The factors used to estimate POME production in the SADP area range from 0.6 to 0.8 tonnes POME per tonne of FFB processed. Data from four mills examined in this study show this factor to range between 0.4 and 1.1t of POME per tonne of FFB processed (see Figure 3). The influence of process technology is evident as Mill 4 is the Numundo Mill which has the Westfalia ECO-D system (automatic sand removal cyclone and a 2-phase decanter) giving a lower POME production factor. Poor operational practices are also illustrated by, for example, mill 3 that during October 2006 produced some 1.77 tonnes of POME per tonne of FFB processed – these practices were rectified following internal inspection.

The significance of having combined POME in treatment system design is illustrated in the following example. In this example it is assumed that a 60t/hr mill occupies a 3ha site, and that during periods of rainfall some 70% runs-off and flows into the POME treatment system. So during the rainy season where for instance 2mm of rain falls in one hour, both the process effluent (raw POME) and the surface water run-off will equal 42t (giving 84t of combined POME). If not accounted for in the design of the treatment system rainfall can readily lead to flooding, and inadequate treatment.

[20] www.westfalia-separator.com

Figure 3
POME production per tonne of FFB milled



2.3 *Potential environmental impact*

The potential environmental impacts of POME are dictated by how it is managed and treated, these potential impacts include:

- Impacts on the receiving aquatic environment via oxygen depletion. This can be a direct process where oxygen is removed from a receiving water body leading to a reduction in biodiversity, changes in species composition and dominance, and in extreme circumstances toxicity effects, or an indirect process where excess nutrient supply stimulates excessive plant (especially algae) growth which removes oxygen from the aquatic environment and further may decompose, leading to potential odour, production of toxins, increased turbidity of the water and consequent loss of its perceived aesthetic value.

- Health impacts. No studies have been identified looking at the health impacts of POME although by its nature, for example the temperature on leaving a mill, it presents an occupational health risk rather than an environmental consideration. Environmental health concerns might result from oxygen depletion in water bodies, complaints about odour and tainting the taste of water contaminated by POME.

  (Note POME treatment ponds may be used as a sink for septic tank debris - this is generally loaded into the cooling/acidification pond where sterilisation should take place owing to the initial high temperature of POME received from the mill or by subsequent treatment in shallow aerobic ponds exposing any pathogens to Ultra Violet light).

- Air pollution and atmospheric impacts. POME and its treatment produce gases which are pungent at relatively low concentrations – the most notable are volatile fatty acids (VFA) and hydrogen sulphide. Treatment also generates significant volumes of methane that if released to atmosphere has a global warming potential 21 times that of carbon dioxide.

2.4 Treatment

POME is a colloidal suspension brownish in colour (see photo 1) with a high organic content and nutrients. Typically it contains 95–96% water, 0.6–0.7% of oil and grease and 4 – 5% of total solids. The most striking characteristic of POME is its strength measured as Biochemical Oxygen Demand (BOD), at between 10,000 - 44,000 mg/l this is as much as 125 times the strength of typical raw urban sewage 350 mg/l. The chemical properties of POME vary widely (as shown in Table 3) and depend on the operation and quality control of individual mills. Besides the organic composition, POME is also rich in mineral content, particularly phosphorus (18 mg/l), potassium (2,270 mg/l), magnesium (615 mg/l) and calcium (439 mg/l). Thus dewatered/dried POME sludge can be recycled or returned to plantations as fertiliser with the appropriate safeguards.

Table 3
POME Characteristics

Parameter	Mean	Range
pH	4.2	3.4 – 5.2
Biochemical Oxygen Demand [a]	25,000 mg/l	10,000 – 44,000
Chemical Oxygen Demand	50,000 mg/l	15,000 – 100,000
Total Solids	40,000 mg/l	11,500 – 78,000
Suspended Solids	18,000 mg/l	5,000 – 54,000
Oils & grease	6,000 mg/l	150 – 18,000
Ammoniacal nitrogen	35 mg/l	4 – 80
Temperature	Variable	80 -90
Total nitrogen	750 mg/l	180 -1,400

Source: PNG Environmental Code of Practice for PNG Oil Palm Processing Industry
a – PNG CoP refers to biological oxygen demand; biochemical oxygen demand is now the term more commonly used for the same parameter.

To avoid gross local pollution POME must be treated before release to the environment. Treatment at mills in PNG and the great majority of mills internationally is in ponds (sometimes referred to as lagoons). The term ‘pond’ is somewhat imprecise as it implies a treatment system of lesser complexity than industrialised treatment processes – this is true mechanically but not in terms of the biological reactions that take place. The greater simplicity of pond designs means they are cheaper to construct and require less intensive maintenance and control. These advantages have the cost of long hydraulic retention times, a corresponding greater land requirement and potentially unsightly and odorous facilities. They are employed where financial resources, skilled labour and access to process technology are at a premium but land is not. They are also more suited to warmer climates like PNG where conditions are favourable for microbial activity throughout the year.

Photo 1
Discharge to an anaerobic pond

POME treatment ponds are designed in series and are generally separated as follows - the earlier stages are more significant in reducing organic load. Detailed design is governed by desired treatment standard, hydraulic and organic load, and site-specific considerations.

- Cooling pond which receives hot POME from the mill effluent pit.

- Acidification pond this is the first phase of the anaerobic digestion process. It is a rapid process where acid bacteria convert particular organic components into volatile fatty acids (VFA) that form a substrate for the next phase of the anaerobic process. This is often combined with a cooling pond.

- Anaerobic pond where a considerable BOD reduction is achieved by the action of hydrolytic, fermentative and methanogenic bacteria in four distinct hydrolysis, fermentation, acetogenisis and methanogenisis. These reactions take place in the absence of oxygen. Anaerobic ponds are quite deep (up to 7m) and generally have a layer of scum[21] on the surface. If too shallow and without a scum layer, oxygen can transfer between the air-water interface which will change the microbial composition impacting on the rate of organic matter digestion. Given the high strength of POME, a single anaerobic pond may not be sufficient and two or more are constructed in series to

[21] Scum might comprise dead bacterial bodies and suspended solids bought to the surface by rising bubbles of gas; the latter is exaggerated by the presence of oils and greases. Scum accumulation of the wrong type impairs a pond's effectiveness.

achieve greater BOD reduction. The hydraulic retention time (HRT)[22] is generally a minimum of 30 days depending on the organic loading but 45 days is appropriate for designing POME treatment ponds[23].

- A facultative pond achieves treatment by a combination of aerobic oxidation, photosynthesis and anaerobic digestion. Settleable and flocculated effluent from the anaerobic pond settles to the bottom of a facultative pond where organic matter is decomposed anaerobically. In the upper liquid layer oxygen from surface transfer and produced by algae is used by aerobic and facultative bacteria (can live under aerobic or anaerobic conditions) to stabilise organic material. Facultative ponds are usually 1 to 1.5m in depth and have shorter retention times of some 20 days.

- An aerobic pond provides further treatment where the effluent becomes less acidic. Effluent quality is improved by removing the suspended solids, ammonia, nitrate, phosphate concentration and also the number of enteric (found in the intestines of humans and other animals) micro-organisms. A typical retention time is around 14 days. Aerobic ponds are less than 1m in depth to allow algal development and the transition of oxygen.

- Final settling pond: this can be used to settle suspended solids from the aerobic pond. This process might occur in drainage channels prior to discharge to the environment.

In constructing ponds depth is crucial for determining the type of biological processes that take place and the residence time to achieve the desired standard of treatment. Depth is limited in areas with a high water-table; such locations are not suited for construction of anaerobic ponds in particular, unless built upwards which will require suitable engineering and may add to costs. Also considered in the design should be a freeboard (additional depth) to allow for hydraulic upsets, sediment accumulation and excess precipitation therefore minimising the risk of flooding. Pond length and width differ depending on the availability of land. The number of ponds and whether they are built in series or parallel will depend on the production capacity of each palm oil mill and maintenance considerations. Pond bottoms should be as flat and level as possible (except around the inlet) to facilitate the continuous flow of the wastewater. Rounded corners help maintain the overall hydraulic pattern preventing flow dead-spots (short circuiting) which can affect treatment quality. There is some debate about whether POME ponds should be lined as effluent will percolate into the ground and may get into groundwater – a risk, given the high porosity in many project areas. It is suggested that the rate of percolation will reduce over time because of the formation of a sediment layer at the bottom of the ponds.

Pond operation is controlled by load application, the transfer of effluent between ponds, ensuring adequate mixing within and between ponds and maintenance in the form of preventing

[22] A measure of the average length of time that a soluble compound remains in a constructed reactor. It is calculated basically by dividing the volume of a unit process by the applied flow rate.

[23] 'The Oil Palm' - R H V Corely 2003

excessive accumulation of solids. Excess solid accumulation will lower the effectiveness of the pond by reducing the volumetric capacity and HRT. A specialised part of desludging is the recovery of 'acid oil'. This is oil that has entered into the treatment system and not been digested; usually evident visually, it can be recovered commercially and processed for secondary uses such as floor polish.

Ultimately the adequacy of a pond system is determined by the quality of the final effluent; however, an experienced operator can assess pond health visually and by type and intensity of odours. A more scientific insight into the biological processes taking place through the pond system is gained by measuring different parameters between ponds (temperature, BOD, acidity, VFA and alkalinity). With this information load can be regulated and circulation modified to ensure better performance. Given the volumes of effluent in a pond treatment system it takes a relatively long time for pond operation to fail but conversely, if it fails, it takes a long time to rectify.

There are a number of potential modifications to the treatment system described above. These have two often-related aims, more consistent and improved treatment and a reduction in pond area. The most capital intensive is to use mechanical or high-rate treatment for example the use of membrane bioreactors which substantially reduce the required pond area. Others include the use of flocculants to speed removal of suspended solids and the application of nutrients to encourage the optimum conditions for bacterial growth. High-rate oxidation systems are currently not used in PNG.

2.5 Use and disposal

Given the nutrient content of treated POME it can be a useful fertiliser addition or substitute; however, if the treatment system is too efficient the fertilising benefit is reduced. To avoid excessive nutrient loss POME might be taken from earlier stages in the POME treatment system for this purpose.

When used for fertilisation there are two basic options: direct application to plantations or application to EFB to create compost (see photo 2). The former can be expensive in terms of pipe work and pumping cost; must be applied to the root horizon to match application needs, and must be treated to the standard for land application. The latter can be more readily controlled and may be more cost-effective if managed appropriately. Compost can then be used in nursery operations reducing or removing the need for topsoil and providing a more controlled growth medium.

Treated POME can also be applied to land for irrigation. In practice in PNG this involves disposing to trenches (deeper than the root horizon) for dispersal into groundwater (see bottom right photo on report cover). The design of such systems must be sufficient to avoid water logging. The alternative is to discharge treated POME to a suitable water body. This requires compliance with applicable legislation.

Section 2.4 discusses how anaerobic treatment of POME produces large quantities of methane which has a significant global warming potential (GWP). There is a drive inspired by the Clean Development Mechanism (CDM)[24] to capture this methane for either flaring to reduce its GWP, or for combustion not only to reduce its GWP but also to produce energy (usually electricity). The former might take place in the absence of local demand or connection to the electricity supply network, while the latter is preferable. To encourage the latter type of developments, the Worldwide Fund for Nature (WWF)[25] has developed criteria for Gold Standard projects that are not only registered with the UN CDM Board but make measurable contributions to sustainable development. The aim of this independent standard is to allow branding in the trade of carbon credits. To date some 51 POME biogas projects have been registered with the UN CDM Board, approximately 17 having failed the demanding assessment process, and some 49 are currently going through the verification process.

Adoption of methane recovery will not negate the need for subsequent treatment and subsequent use or disposal of the remaining liquid effluent (which will have a signifcantly lower organic content than raw POME).

Photo 2
EFB converted into humus in 20 weeks given the appropriate conditions
(Photo provided courtesy of NBPOL)

2.6 Summary of treatment options

Overtime the approach to POME management has passed through various stages of sophistication. This change has been driven by legislation, external pressure (from international funding bodies, NGOs and large palm oil customers) as well as the contemporary environmental policies voluntarily adopted by the milling companies. With the growing body of knowledge, experience and control, milling companies can make more informed choices about how they wish to manage POME based on the environmental and commercial circumstances at a given

[24] This is under the United Nations Convention on Climate Change.
[25] The Gold Standard for CDM was developed in 2003 by Worldwide Fund for Nature (WWF), SouthSouthNorth, and Helio International. As of March 2009, 60 environment and development non-profit organisations endorsed the Gold Standard as a means to encourage emission reduction projects that promote sustainable development and benefit local communities.

mill location. Sophisticated POME management may involve modification of the milling process, the addition of supplements to improve the standard of effluent treatment and use of POME as a resource rather a waste requiring management and disposal.

3.0 Regulation and management control

This section outlines regulatory and policy control mechanisms for ensuring responsible management of POME. The following concentrates on regulation and control as it applies to wastewater, other policies concerning general environmental performance and public consultation are addressed in other documents referenced in this study.

3.1 World Bank

The World Bank has a series of ten safeguard policies that require the identification of potential environmental and social impacts associated with Bank investment projects. The objective of these policies is to integrate the issues in decision-making to support environmentally and socially sustainable development. The most applicable to this study are OP 4.01 and BP 4.01 both titled 'Environmental Assessment'. Operational policies establish parameters for the conduct of operations and bank procedures explain how bank staff realise an operational policy.

Under the environmental screening process of OP/BP 4.01, the SADP was determined to be a category B project. In line with bank policy an Environmental Assessment (EA) was completed in January 2007 and an associated Environmental Management Plan (EMP) produced[26]. These documents focused on the major parts of the SADP investment notably infilling and road construction. This effluent study complements the EA and EMP.

In support of the bank environmental and social safeguard policies, the World Bank group has a series of technical reference documents[27]. The most applicable to this study are the 1998 Pollution Prevention and Abatement Handbook, the Guideline 'Wastewater and Ambient Water Quality' and the 2007 Guideline on 'Vegetable Oil Processing'. These documents provide principles, define technical and managerial terms and give a basis to establish a structured approach to water and wastewater management across industry sectors. A summary of the Guideline on Wastewater and Ambient Water Quality applicable to this study is given in Box 1.

[26] These were undertaken by the Oil Palm Industry Corporation that commissioned Douglas Environment to do the work.
[27] http://www.ifc.org/ifcext/sustainability.nsf/Content/EHSGuidelines

Box 1
World Bank Group Guideline on Wastewater and Ambient Water Quality

Applicability and Approach
In the context of an Environmental Health and Safety management system, facilities should

- Understand the quality, quantity, frequency and sources of liquid effluents in its installations. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points
- Plan and implement the segregation of liquid effluents principally, in order to limit the volume of water requiring specialised treatment.
- Identify opportunities to prevent or reduce wastewater pollution through such measures as recycle/reuse within their facility, or process modification (e.g. change of technology or operating conditions/modes).
- Assess compliance of their wastewater discharges with the applicable: (i) discharge standard and (ii) water quality standard for a specific reuse (e.g. if the wastewater is reused for irrigation).

When wastewater treatment is required prior to discharge, the level of treatment should be based on:

- National and local standards as reflected in permit requirements
- Assimilative capacity of the receiving water for the load of contaminant being discharged wastewater if discharge is to surface water
- Intended use of the receiving water body
- Presence of sensitive receptors

General Liquid Effluent Quality
Discharge to Surface Water
Discharges of process wastewater or storm water to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- Process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines (A);
- Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone.

Land Application of Treated Effluent
The quality of treated process wastewater or storm-water discharged on land should be based on local regulatory requirements. Where land is used as part of the treatment system and the ultimate receptor is surface water, water quality guidelines for surface water discharges specific to the industry sector process should apply. Potential impact on soil, groundwater, and surface water, in the context of protection, conservation and long-term sustainability of water and land resources should be assessed when land is used as part of any wastewater treatment system.

Monitoring
A wastewater and water quality-monitoring program with adequate resources and management oversight should be developed and implemented to meet the objective(s) of the monitoring program.

(A) EHS Guideline on Vegetable Oil Processing
This guideline addresses: examples of good international industry practice; industry-specific impacts and management; probable industrial wastewater flows, possible wastewater treatment techniques and gives guidance on performance standards (see Table A).

The Guideline contains the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables are taken into account.

Table A. Effluent levels for vegetable oil processing		
Pollutants	Units	Guideline value
pH	pH	6 – 9
BOD5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone

3.2 National regulation

The primary piece of legislation concerning natural resource management is the Environment Act 2000 (as amended 2002 & 2010) that became fully operative in 2004. The Act and the Environment (Prescribed Activities) Regulation 2002 define environmental assessment requirements for the issuing and maintaining of permits.

Paragraph 42 of the Act separates activities into three levels depending upon their environmental implications and size. For new developments EIAs are required for level 3 developments and may also be required for level 2 developments. New palm oil mill developments are level 2 developments (Category B subcategories 8.5 and 9.5 - agricultural cultivation of an area greater than 1,000 hectares and palm oil extraction and processing in plant producing more than 5,000 tonnes per year).

Level 2 activities require an environmental permit prior to construction and for operation. This is usually the same permit. Permit durations vary, for example, the permit for Navo Mill is 50 years whereas that for Hargy Mill is 25 years. This illustrates that there are inconsistencies in the award of permits throughout the project area. This is further complicated by the often slow reply from the regulatory authority to requests, and the ‘transition period’ from the Environment Planning Act, Environmental Contaminant Act and Water Resource Management Act to regulation under the Environment Act 2004. This transition period is being used by NBPOL to integrate all its activities under a single umbrella. It is anticipated that this will be completed by December 2010.

The Department of Environment and Conservation (DEC) is the principal national government agency responsible for environmental legislation, issuing permits, their enforcement and compliance monitoring. Under the Organic Law, provinces and local government have the authority to make their own laws for ‘transferred powers’, pass by-laws and take on responsibility for implementing the various pieces of National Government Legislation (evidence suggests this is more of a possibility than a reality)[28].

In July 2010 DEC employed some 50 staff of whom approximately 20 are scientifically trained, a small number of whom have more than seven years professional experience. This team is charged with regulation across the whole country for all major industry sectors (including the environmentally high-profile mining industry and the LNG project). In addition to constraints in staff numbers, DEC has budgetary constraints in making annual site inspections required under the Environment Act. The DEC is based in Port Moresby and companies requiring inspection are expected to pay at least the transport cost and expenses of inspectors during site inspections that are anticipated to take place annually.

In May 2010 a significant amendment was made to the Environment Act and realised through the Environment (Permit Transitional) Regulation 2010. The thrust of this change is to give the possibility to circumvent provisions in the Act by giving the Director of DEC the direct authority to grant an Authorisation (deemed a permit) for specific acts or works, and further issue Exception Certificates for chosen activities.

<u>Environment (Water Quality Criteria) Regulation 2002</u> this regulation gives criteria for the protection of aquatic life in both fresh and sea water. It may identify a 'mixing zone' where it is not necessary to meet the water quality criteria; however, this provision does not tend to be applied except to the mining industry. More precise calculation of the size and monitoring compliance with specified mixing zones requires the contribution of suitably trained scientists.

<u>Environmental Code of Practice PNG Oil Palm Processing Industry 1997</u> this Code of Practice developed jointly by the industry and the Department of Environment and Conservation aims to help the industry to achieve *'sustainable use of our natural resources for the collective benefit of current and future generations'*[29]. As such the Code is used as basis for regulation.

As well as stating that '*as much as practicable water from mills should be segregated to allow clean (uncontaminated) water to leave the mills without the treatment systems'*, Section 5.5.2 of the Code gives standards for discharge of treated POME (Table 4).

[28] Country Environmental Profile Papua New Guinea February 2006 (Report sponsored by the European Commission)
[29] Environmental Code of Practice PNG Oil Palm industry 1997

Table 4
Discharge standards for mill effluent

Criteria		
Parameter	**Land**	**Water**
BOD	5,000 mg/l	100 mg/l
pH	5 – 9	5 – 9
Total Solids	4,000 mg/l	'Ref a law' [a]
Suspended Solids	1,000 mg/l	[a]
Oil and Grease	50 mg/l	[a]

a – as written in the Code

Section 5.5.3 of the Code mentions application of residual sludges from treatment systems to land but no standards for application are given.

It is anticipated that this Code of Practice will be updated in early 2011.

3.3 *Roundtable on Sustainable Palm Oil and ISO 14001*

There are many synergies between ISO 14000 and the requirements of the RSPO. This subsection gives an overview of both systems and states how they are being combined. Lord (NBPOL) and Ross (Environmental Monitoring Ltd) explain the incorporation of the RSPO Principles and Criteria within the ISO 14001 framework in more depth in a paper [30].

The Environmental Management System (EMS) standard ISO 14001 specifies a framework of control. It allows an organisation to enter into the process of establishing an EMS at any level (i.e. with an advanced environmental performance or when there is scope for significant improvement) provided demonstrable commitments are made for continuous timely improvements. As part of ISO and RSPO integration, these commitments are made against the RSPO principles and criteria. In some instances these are synonymous such as legal compliance (ISO clause 4.3.2 and RSPO Principle 2) but for others RSPO principles and criteria enable ISO requirements to be made more specific to the oil palm industry.

ISO 14001 is based on an iterative Plan-Do-Check-Act model for an organisation to establish, implement and maintain its environmental policy. The standard gives an organisational framework comprising five main elements: Policy, Planning, Implementation, Measurement and Evaluation, Review and Improvement. Organisations can seek to be audited by approved inspection bodies with the objective of receiving third party certification that the environmental management system is working effectively and that all of the required controls are documented and operational.

[30] http://www.rspo.org/files/pdf/RT3/Proceedings/rosslordrt3paper04nov.pdf

The Roundtable on Sustainable Palm Oil (RSPO) is a not-for-profit association that seeks to develop global standards for the production of sustainable palm oil. It brings together stakeholders in palm oil - producers, processors/traders, consumer goods manufacturers, retailers, banks and investors, environmental/conservation NGOs and social/developmental NGOs.

The RSPO has produced Principles and Criteria for Sustainable Palm Oil Production[31] where it defines sustainable production as *'comprised of legal, economically viable, environmentally appropriate and socially beneficial management and operations'.* Delivery of 'sustainable palm oil production' is through application of eight principles and 39 associated criteria. Like ISO 14001, companies must seek third party certification to demonstrate application of these principles. At the time of writing this report 13 certification bodies were RSPO-approved to fulfil this function[32]. Most if not all are also approved to give certificates of conformance to ISO 14001. Both HOPL and NBPOL are certified to ISO 14001 and RSPO standards.

The most applicable principles and criteria for this effluent study are shown in Box 2 a longer version is given in Appendix 2. As the principles and criteria were developed to apply in a number of countries, RSPO working groups have established working groups for national interpretation (that for PNG can be found on the RSPO website 'Projects and Work Groups'). Beneath criterion are sets of indicators that must be complied with in order to receive or maintain certification. For example for Criterion 4.4 'Practices maintain the quality and availability of surface and ground water' in the PNG national interpretation a key wastewater indicator is:

4.4.1 An implemented Water Management Plan in Compliance with PNG DEC Water extraction and discharge permits and including but not limited to: the Monitoring of effluent BOD (mg/l) trend for previous 12 months, mill water use per tonne of FFB trend for previous 5 years, storm water, drains, nursery and domestic usage.

[31] RSPO Principles and Criteria for Sustainable Palm Oil Production (Including Indicators and Guidance) October 2007
[32] http://www.rspo.org/?q=page/512

Box 2 **RSPO Principles and Criteria (most applicable to this study)**
Principle 1: Commitment to transparency **Principle 2**: Compliance with applicable laws and regulations **Principle 4**: Use of appropriate best practices by growers and millers Criterion 4.4 Practices maintain the quality and availability of surface and ground water. With indicators: • An implemented water management plan. • Protection of water courses and wetlands. • Monitoring of effluent BOD. • Monitoring of mill water use per tonne of FFB . **Principle 5**: Environmental responsibility and conservation of natural resources and biodiversity Criterion 5.3 Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner. **Principle 6**: Responsible consideration of employees and of individuals and communities affected by growers and mills **Principle 8**: Commitment to continuous improvement in key areas of activity

3.4 The Oil Palm Companies

Each of the operations in the SADP project area has or is pursing RSPO and ISO certification. Besides a desire to act and been seen to act responsibly, there is a commercial drive to distinguish palm oil from PNG in the international market place on the basis of its sustainability.

There are three commercial entities in the SADP project areas, NBPOL in Hoskins, HOPL in Bialla and Higaturu in Oro but looking forward in terms of environmental management there are effectively two following the recent take over of Higaturu by NBPOL. Both NBPOL and Hargy are certified to ISO 14001 and the RSPO Principles and Criteria. NBPOL received RSPO certification in September 2008 and Hargy in April 2009. Despite CTP (PNG) Ltd. the former owner of Higaturu having had an initial RSPO certification assessment in October 2009, assessment for full certification has been postponed following the takeover by NBPOL. There are a number of reasons for this that is beyond the scope of this study. NBPOL/KOPL will seek certification in 2011 and 2012 following a period of transition.

It is not the scope of this study to assess implementation of these management systems, which is the function of the certification bodies. However it is noted that there are annual RSPO and ISO audits, annual inspections by DEC as well as more frequent internal audits and inspections against system standards. During preparation of this study EMS documentation was examined to assess the existing POME management procedures. Some documentation and procedures are developing and will be improved as part of maintenance of RSPO and ISO certification.

Each of the operations NBPOL/HOPL & KOPL) has sustainability officers who deal with environmental management in conjunction with engineering and plantation colleagues. They work in dedicated teams across a number of mills. Within NBPOL there is a sustainability director[33] who reports to the company board.

Each of the operations has prepared an Environmental Aspects and Impact Register and all identify wastewater management. Each company has management guidelines and procedures (including sampling methods) that apply to POME management, although none were seen concerning pond design and operation during site visits[34]. All sites are familiar with the discharge standards for POME given in the PNG Code of Practice, and all sites send effluent samples to the National Analytical Laboratory for analysis. In compliance with ISO 14001 the companies have systems in place to record non-compliance with company operating practices and procedures (it was noted during site inspection that some referenced documents were not current). This includes a grievance procedure, part of which includes grievances from the local community. When a grievance is recorded it must be investigated and closed out in a reasonable time period. Both companies are committed to transparency within commercial bounds.

It is noted that NBPOL is in the process of employing a fulltime pond specialist to enhance the technical competence of its pond management practices across its operations.

Recently there has been a transition in staff across many of the sites, which has resulted in loss of experience and knowledge of site history. This will add to operational challenges but ought to be addressed in the competency and training requirements of ISO 14001.

3.5 Summary

There are recognised challenges in the implementation of environmental regulation in PNG. The adoption of certified environmental or 'sustainability' management system allows the oil palm companies to both gauge and demonstrate responsible environmental management. Such demonstration is valuable in the market place but also within the community. In relation to the community, reference to systems and certification ('*by organisations paid by the companies*') does not always provide comfort so there remains a challenge in promoting confidence in the system. The companies are tackling this through stakeholder engagement garnered through RSPO Principles and Criteria and ISO 14000 requirements.

In practice many of the requirements in the World Bank Guideline on Wastewater and Ambient Water Quality should be addressed by proper implementation of ISO 14001 and RSPO. Where they are not, they ought to be in the future, given the requirement in both systems for continuous improvement. There is a notable difference however between national law/ISO/RSPO discharge standards and those given in the Bank Group EHS Guideline on Vegetable Oil Processing which are significantly stricter than those adopted by the palm oil industry in PNG (and other countries).

[33] An ex-Vice President of the RSPO
[34] A training presentation on managing effluent ponds was inspected at Kapiura mill

4.0 Monitoring

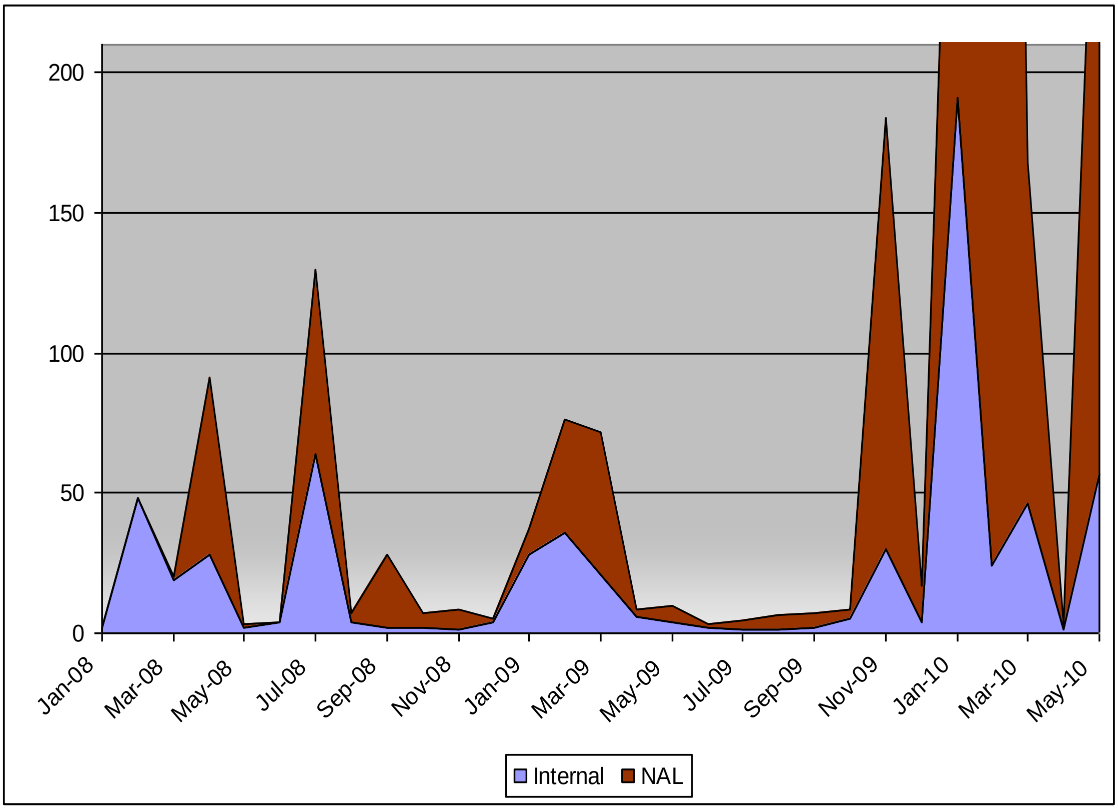
Monitoring effluent flow and quality is fundamental for robust POME management. The collection and analysis of suitable data enables the appropriate management control and compliance with policy and regulations. During preparation of this study it was observed that some sites would benefit from additional monitoring. For example greater use of flow meters will enable design or operational modification to reduce the risk of pond flooding; and more targeted and timely in pond quality monitoring will give greater understanding of the biological processes taking place and subsequently enable actions to optimise pond performance.

In addition to the extent of monitoring there are issues over data quality. Permits for discharge issued by DEC require holders to carry out a water quality programme. A requirement is to send effluent and water samples to the National Analytical Laboratory (NAL) in Lae on a monthly basis for analysis. Given the journey times to Lae - the only government approved laboratory in PNG – and the handling required, there is a risk of variable results. For example this might lead to a consistent over recording of 5 day Biochemical Oxygen Demand.

Figure 4 shows a comparison between the BOD results obtained for a given environmental impact point from the NBPOL laboratory and from the NAL. Generally the company results are lower suggesting systematic rather than random error at one or both laboratories. It is recommended that detailed statistical analysis is undertaken to identify reasons for this variation. Some actions might include: greater use of standard solutions, determination of 'accepted' test precisions, use of 'trip blanks' to identify potential systemic error at NAL[35], and exchange of samples between company laboratories (i.e. between mills and the three businesses) as part of a quality programme.

[35] During the review of this study NBPOL have noted that NAL is no longer an accredited laboratory. The NBPOL laboratory is certified under ISO 14000.

Figure 4
Comparison between monthly company and NAL BOD_5 monitoring data



5.0 Current SADP project area mills

This section identifies the current and planned FFB production for the respective project areas to demonstrate when new milling capacity is required, it gives a brief history of each mill[36], comments on respective layouts and operations, describes the environmental setting and reviews current environmental performance. Where necessary the reader should make reference to earlier sections in the document for discussion on process, regulation and data quality. The following does not make detailed assessment of the adequacy of pond design other than reviewing discharge performance.

With the exception of the Mamba Mill ponds none of the ponds in the SADP are lined and so given the porous nature of the soils in PNG, there is a theoretical risk that POME may infiltrate into groundwater. This question was asked during some site visits but no comments were received or observations made to indicate this is a risk. For most if not all sites the most proximate groundwater users are the companies who analyse water quality on a regular basis, so any theoretical infiltration would be observed and can be acted upon.

5.1 Hoskins

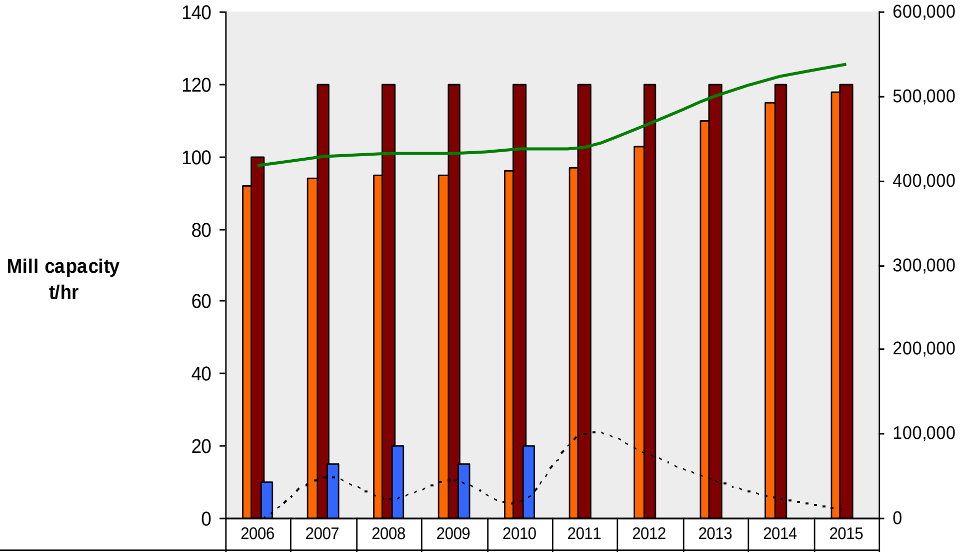
Production in Hoskins is separated in three operational areas: Mosa Group which includes Kumbango Mill and 10 managerial units that contain plantations and smallholders; Numundo Group which will include Waraston and has 13 managerial units and Kapiura Group with 8 managerial units. The budgeted FFB production and associated milling capacity for each group is shown in Figures 5 to 7[37] - this includes the anticipated 120,000 t/yr FFB from the SADP.

The figures show that FFB is transported between operational areas in order to balance crop production with milling capacity and that new mills are planned for the Numundo and Kapiura groups. The new capacity noted in Figure 6 is the 60t/h Waraston Mill which is due to be commissioned in the first quarter of 2011.

[36] Site history is given where readily available during field investigations and write up period. It is not exhaustive and more detailed for some sites owing to the knowledge available; it does not seek to imply differences in environmental performance between respective sites.

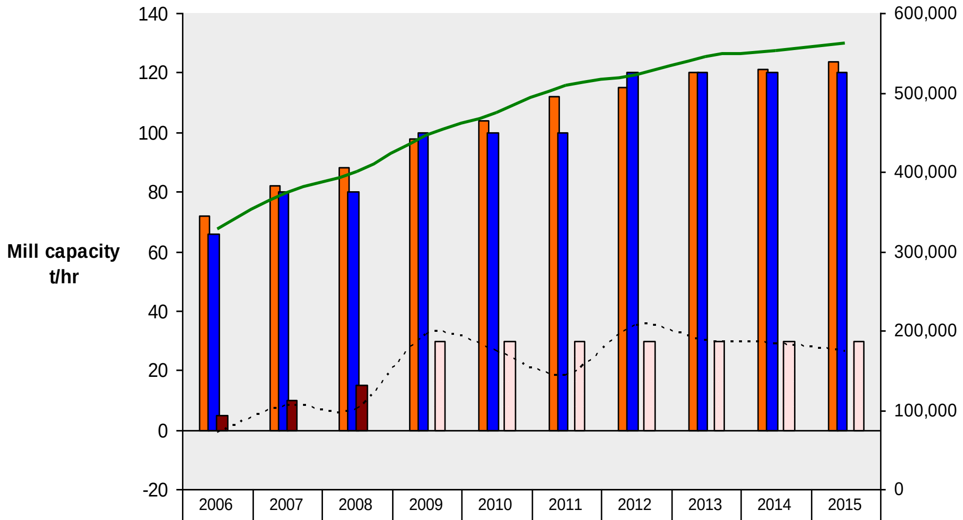
[37] These figures have been produced for strategic planning; annual budgets are completed in September each year.

Figure 5
Mosa Group production estimates and milling capacity
(MOM – Mosa Oil Mill, KOM – Kumbango Oil Mill,
NOM – Numundo Oil Mill)



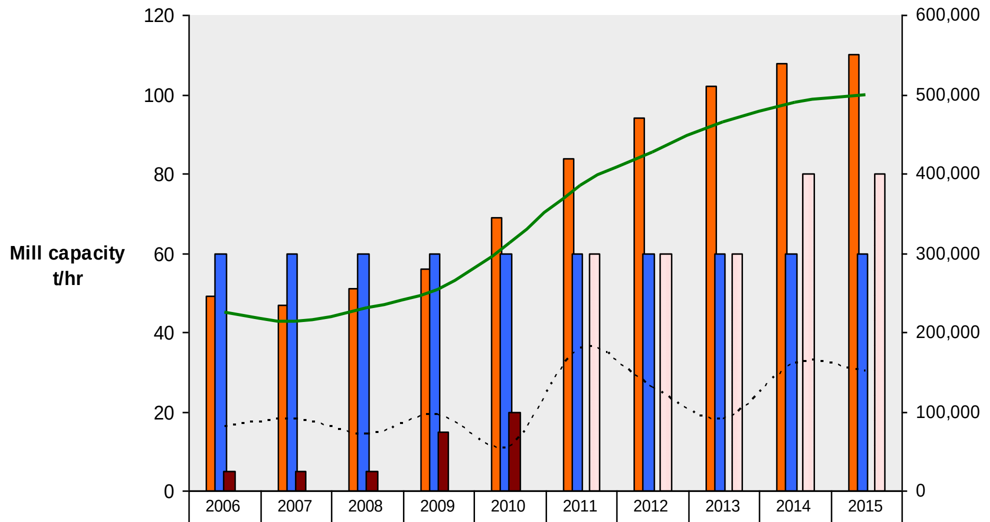
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Peak capacity required	92	94	95	95	96	97	103	110	115	118
Total MOM & KOM capacity	100	120	120	120	120	120	120	120	120	120
Use surplus for NON & KAPOM	10	15	20	15	20	0	0	0	0	0
FFB production t/yr	418,081	428,777	431,922	432,468	437,125	439,411	467,477	500,192	523,329	537,522
Balance of total capacity	-2	11	5	10	4	23	17	10	5	2

Figure 6
Numundo Group production estimates and milling capacity



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Peak capacity required	72	82	88	98	104	112	115	120	121	124
NOM capacity	66	80	80	100	100	100	120	120	120	120
Use MOM/KOM surplus	5	10	15	0	0	0	0	0	0	0
New capacity required	0	0	0	30	30	30	30	30	30	30
FFB production t/yr	327,186	373,672	400,375	446,220	474,835	509,391	522,559	545,439	552,212	562,306
Balance of total capacity	-1	8	7	32	26	18	35	30	29	26

Figure 7
Kapiura Group production estimates and milling capacity
(KAPOM – Kapiura Oil Mill)



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Peak capacity required	49	47	51	56	69	84	94	102	108	110
KAPOM capacity	60	60	60	60	60	60	60	60	60	60
Use MOM/KOM surplus	5	5	5	15	20	0	0	0	0	0
New capacity required	0	0	0	0	0	60	60	60	80	80
FFB production t/yr	223,843	213,857	229,749	253,290	311,502	383,942	425,776	464,551	489,944	498,305
Balance of total capacity	16	18	14	19	11	36	26	18	32	30

5.2.1 Mosa Mill

Mosa Oil Mill (MOM) was commissioned in 1971 and has been modified and expanded from 25 tonnes of FFB per hour to the current capacity of 55 - 60 t/hr. It was not considered viable to expand this mill further so to meet the milling requirement the Kumbango Mill was commissioned in 1981. A summary of recent FFB processed (t) is given in Table 5.

Table 5
Recent milling volumes at Mosa and Kumbango mills (t/yr)

Year	Mosa	Kumbango
2006	263,788	182,359
2007	258,407	216,297
2008	247,114	249,674
2009	285,360	303,010

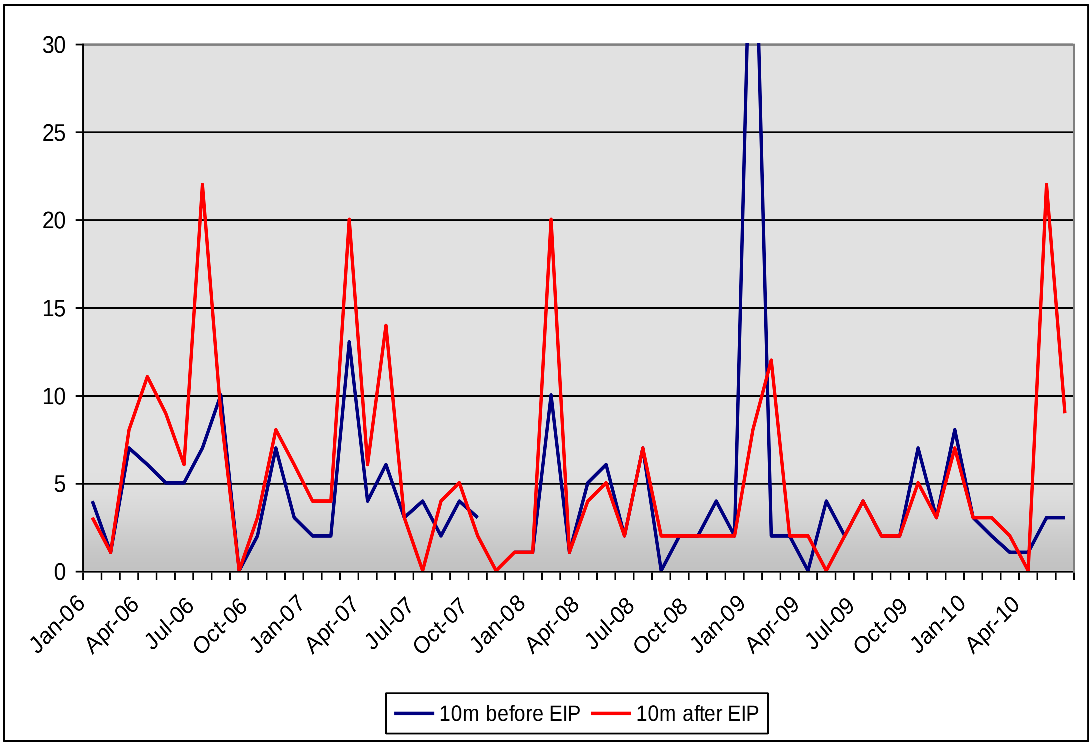
Mosa Mill discharges POME to a cooling pond and six subsequent treatment ponds before flowing in a constructed channel prior to discharge into the nearby River Lameski. This channel flows around the perimeter of the ponds extending the time for settlement prior to passing over a recently constructed weir, which is the environmental impact point (location where samples are taken for compliance monitoring). The treated POME flows some 150m within the company boundary prior to discharge into a small spring-fed watercourse then to the Lameski. A map showing the mill location, effluent ponds and discharge site is given in Appendix 3.

Internal monitoring data show that BOD discharges were below the limit between January 2008 and May 2010 except for one monthly sample. This was investigated and found to be due to an overflow from the cooling pond that ran into the final drainage channel. Using NAL data there were two other occasions when the limit was exceeded. Like all the Hoskins sites, the environmental monitoring regime is thorough in extent[38] taking samples 10m before and 10m after the discharge site (environmental impact point EIP) and at other control points on the River Lameski. Figures 8 and 9 show that the discharge has little impact on the river quality.

It is intended that the Mosa Mill will have an operational methane recovery pond by the end of 2011, this will add to rather than replace existing ponds; the detailed arrangements are being worked on. It is intended that this project will achieve a WWF Gold Standard compliance and the electricity produced will be supplied to the local grid – currently all electricity generated by the local supplier is dependent on diesel generators and is subject to power outages so the realisation of this project will have obvious benefits for the local community.

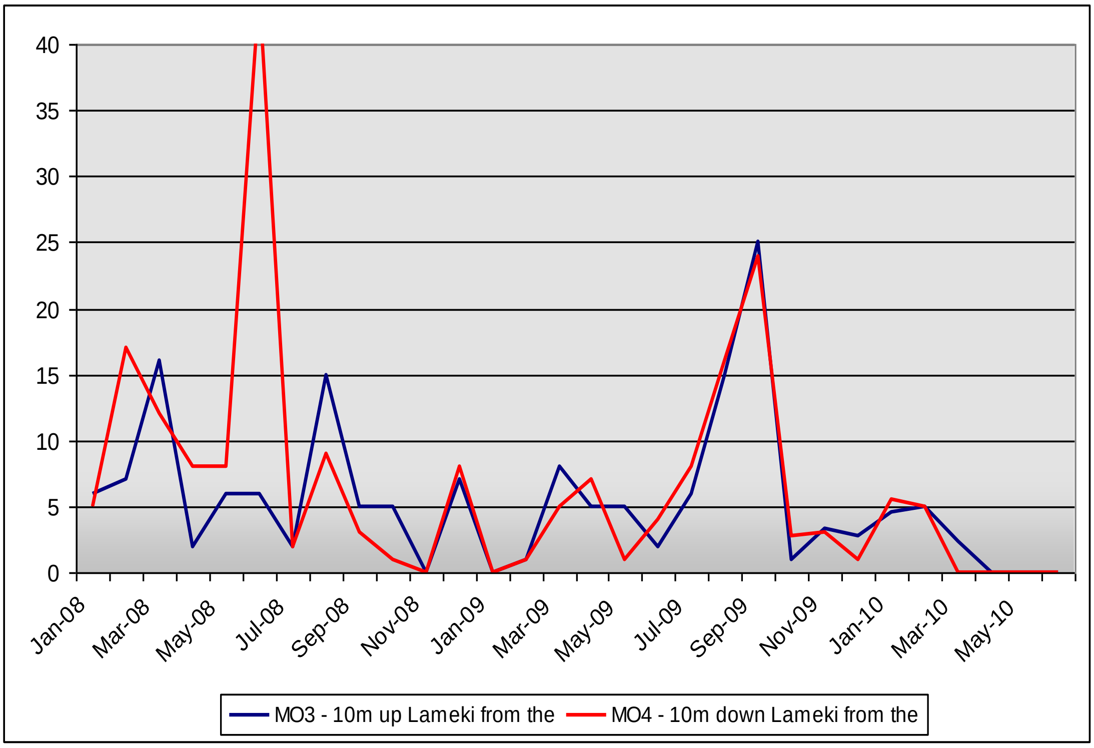
Site drainage is through a separate system and passes through sediment, oil and grease traps before discharge to the environment. It does not flow into the effluent ponds.

Figure 8
BOD mg/l before environmental impact point against BOD 10m after the environmental impact point



[38] Benefit may be gained from more extensive monitoring of additional parameters such as phosphorous and nitrogen to identify the risk of possible eutrophication (either from POME or plantation run-off). A more sophisticated method to assess environmental quality would be to develop biological indicators but this would take time to develop and requires additional skill sets.

Figure 9
Oil & Grease mg/l before discharge in the River Lameski and Oil & Grease 10m after the discharge point



5.2.2 Kumbango Mill

After commissioning in 1981 at an initial capacity of 20 t/hr, Kumbango Mill has expanded incrementally to 30, 40 and in 2008 to 60 t/hr. As part of the most recent capacity upgrade in 2009 a vertical steriliser was installed. Besides allowing more process efficiency this steriliser should require less water and produce less effluent. The mill is located next to the Kumbango CPO refinery owned by NBPOL.

After discharge from the mill effluent pit POME flows to a cooling pond then to a distribution drain from where it is distributed into one of three ponds: 2 x 3 treatment ponds (anaerobic, facultative and aerobic) in parallel and a large holding pond with a capacity of 18,000m^3. The holding pond feeds back to the distribution system, although during site inspection the relative clarity of the large holding pond suggests that at the time they were not being operated this way.

Discharge from the two aerobic ponds flows to one of two parallel settling ponds for final discharge to a drain which flows some 2km through plantation prior to the discharge point into the Dagi River. During site inspection there was evidence of small-scale cultivation on the edge of the river prior to a final silt trap. A map showing the mill location, effluent ponds and discharge site is given in Appendix 4.

Internal monitoring data show that BOD discharges were below the limit between January 2008 and May 2010 except for three monthly results. Again NAL data show more times when the limit was exceeded but on at least one occasion the BOD concentration reported was extremely high suggesting sampling error.

Construction has started on a methane recovery pond at Kumbango located nearer the mill. This project is being developed on a similar basis to that at Mosa mill.

5.2.3 Kapiura Mill

Kapiura Oil Mill was commissioned in 1990 initially with a capacity of 45t/h and increased to 60t/h in 2005/6. There have been recognised issues with meeting discharge expectations that have been both structural (insufficient pond retention times) and operational owing to sludge build-up. Two ponds were added in 2008 and the existing ponds desilted in mid 2009. A description of how the current 10 ponds are operated is not given here as during the site visit they were being reconfigured and structural repairs being made to two pond walls. POME flow to the ponds is combined with site drainage.

Final pond effluent discharges to a channel that flows through some 5km of plantation beside a dirt road. Along its route, it combines with other plantation drainage channels becoming Morubile Creek in a mangrove swamp. The creek combines with further drainage to flow alongside smallholder land before ultimately flowing into Volupai Bay – sampling points and the location of the effluent discharge are shown in Appendix 5.

At the time of site visit, the plantation channel from the ponds was dammed owing to operational difficulties. There was a significant layer of scum on the surface of the dammed liquid suggesting that the ponds had not been adequately fulfilling their function (see photo 3). Some distance after the dam, there is spring water ingress to the channel. During the site visit this water looked clean and supported a population of small fish. Further downstream, when combined with other plantation drainage, there was evidence of eutrophication (nutrient enrichment) shown by a large amount of algal growth. This suggests that unless there is residue from previous partially treated POME discharge, nutrient enrichment might have other causes such as run-off/seepage from fertiliser and/or EFB application to the surrounding land. It is noted however that this area is susceptible to eutrophication given the absence of gradient and slow water movement.

Internal monitoring data show that apart from one month, the BOD discharge at the environmental contact point was below the limit between January 2008 and May 2010. NAL data show two non-compliances.

NBPOL is committed to introducing a methane recovery pond at Kapiura, however it faces a series of obstacles. One is lack of infrastructure connecting to the local grid, an issue to be addressed with PNG Power Ltd.

Photos 3 & 4
Drainage channel dam and evidence of eutrophication

5.2.4 *Numundo Mill*

The mill was commissioned in 2001 and designed to be 40 – 80t/hr mill, the second phase being completed in 2005. The mill trialled the ECO-D decanter, which reduced water demand and produced less effluent with a lower solids content. The mill was designed to be 100% composting – 25% of the compost for nursery use and the remainder to partially replace inorganic fertiliser in the plantations. This vision has now been modified due to operational issues not least water logging at the composting facility. Numundo now has series of recently constructed ponds and trailer-based composting[39]. Trailers are fed with EFB and slurry from the decanter where they are mixed for subsequent application; the remaining liquid effluent from the decanter goes to the ponds.

The layout of the substantial and visually well-constructed ponds is shown in photo 5. This pond configuration was completed earlier this year. Outflow from the final pond is to a channel that flows about 1km through plantation land to the discharge point. On leaving the site boundary combined with other drainage, it flows to the Daliavu River (see appendix 6). Visual inspection showed the drainage channels near the environmental contact point to be clean and supporting small fish and species of *Odonata* (damsel and dragon flies some of which are sensitive to certain types of pollution).

Internal and NAL monitoring data show a high-quality effluent significantly under limit.

NBPOL state that Numundo will develop a methane capture system.

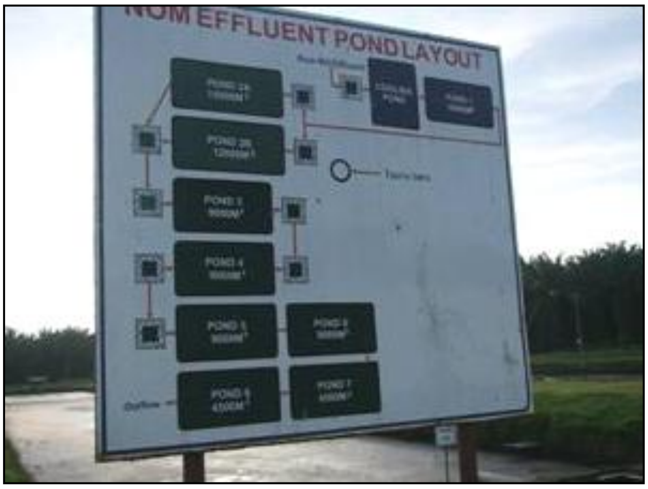


Photo 5
Numundo pond layout

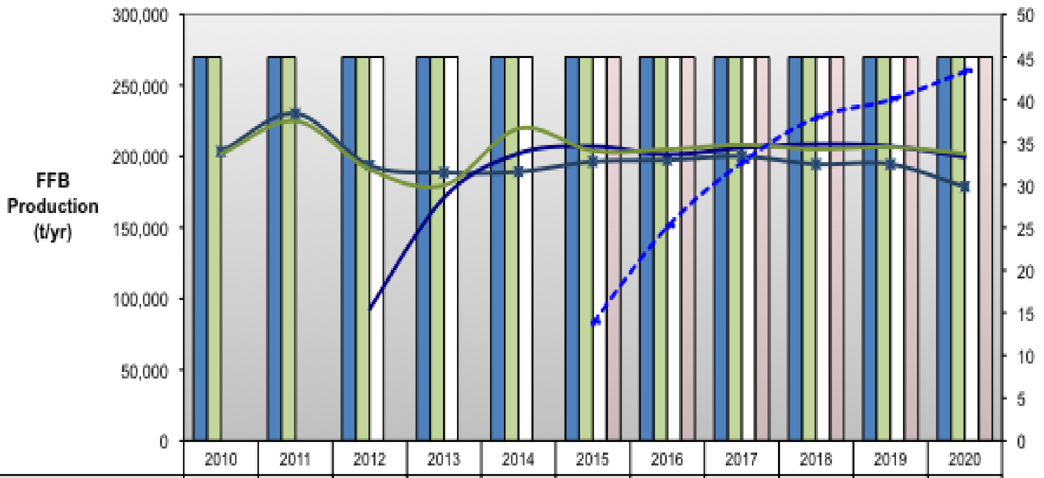
5.3 Bialla

Production in Bialla is divided into three operational areas: Hargy, Navo and Barema. Currently processing is split geographically between the two operating mills Hargy and Navo. When commissioned in July 2012 the Barema mill, situated between Hargy and Navo, will add capacity and an option for matching FFB supply with mill capacity. Currently the Hargy and Navo mills have fixed supply catchments. Estimated FBB supply and milling capacities are given in Figure 10. The figure shows further planned expansion of milling capacity in 2015.

[39] This was not observed during preparation of this study owing to time constraints and was reported by Dr Simon Lord (Sustainability Director NBPOL).

Among the SADP project areas Bialla is characterised by having the largest proportion of smallholder growers. The additional 48,000t/yr of FFB arising from the SADP will be distributed between the three, potentially four, mills.

Figure 10
HOPL production estimates and milling capacity



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hargy mill (t/h)	45	45	45	45	45	45	45	45	45	45	45
Navo mill (t/h)	45	45	45	45	45	45	45	45	45	45	45
Braema mill (t/h)			45	45	45	45	45	45	45	45	45
Expansion mill (t/h)						45	45	45	45	45	45
Hargy FFB prod.	203,448	230,099	193,700	188,622	189,204	196,314	197,440	200,039	194,546	194,512	178,692
Braema FFB prod.			92,674	171,130	202,009	207,113	201,396	206,053	208,613	207,161	199,599
Navo FFB prod.	201,748	224,833	190,852	179,738	219,547	203,968	204,922	208,223	205,145	206,602	201,926
Expansion FFB prod.						82,779	150,510	195,594	227,220	239,866	259,647

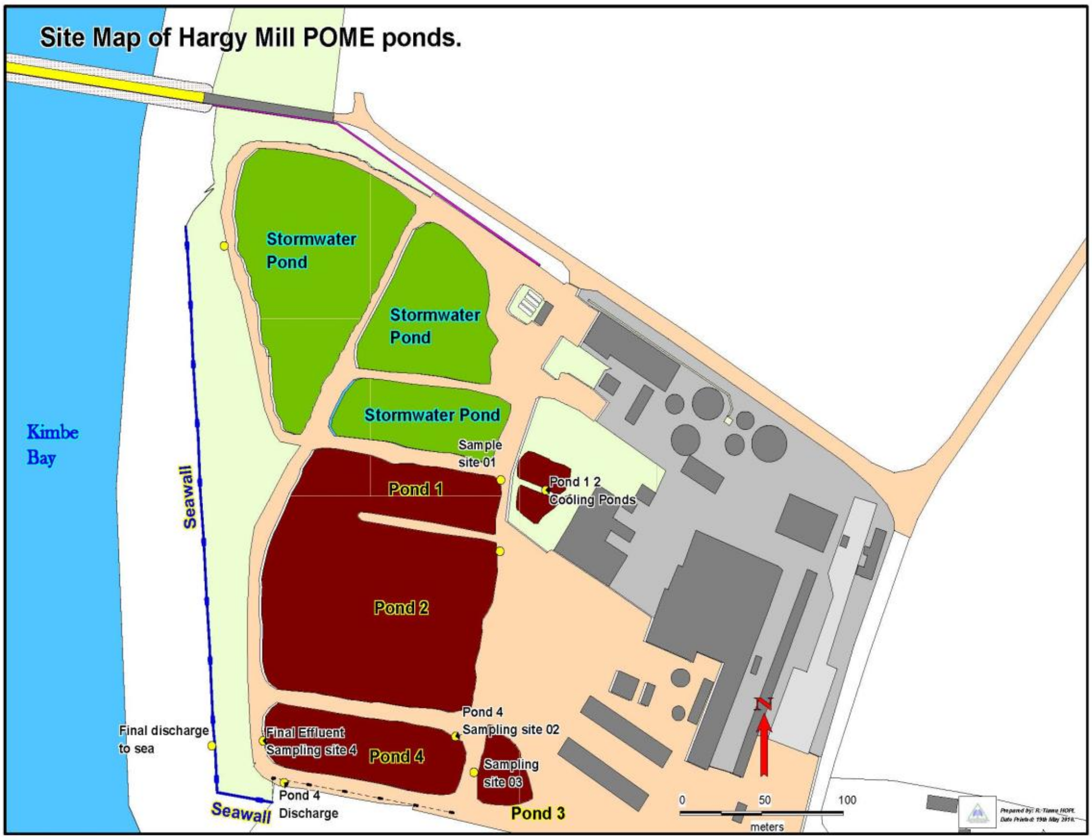
5.3.1 Hargy Mill

Situated next to the sea Hargy Mill was initially built as a mini-mill to process 10 t/hr. The site has since been extensively modified, firstly to 30t/hr in 1980 then to the current 45t/hr. The mill incorporates a 2.4 tons/hr kernel crushing plant, a tank farm of 10,000 tonne capacity, and an export wharf that opened in 1992. The site is space constrained and owing to its coastal location has a high water-table.

During the early period of operation POME was discharged to the Bismark Sea with minimal treatment. In 1989 following a complaint from the nearby Ewasse village and successful compensation claim for environmental damage, the DEC required treatment to be installed. A pond system was subsequently built in 1992 with an atypical design and, owing to the height of the water-table, an 'anaerobic' pond of insufficient depth. The configuration comprises two small cooling ponds followed by a larger pond separated by a baffle and a final treatment prior to discharge to sea (see Figure 11). Pond 3 receives storm water from the site environs that feeds to the final treatment pond, pond 4. Given that this water is largely clean, it dilutes the partially treated effluent while adding to the overall volume.

Large parts of Pond 2 are covered in vegetation (see photo 6). This natural growth may contribute to the breakdown of organic material but is contrary to typical POME pond design and to HOPL Management Guidelines (MG 11), and will reduce pond operating volume. However, monitoring data show that this arrangement generally reduces BOD below limit at the environmental contact point – in the sea 10m from final discharge. The non-compliances in August and the turn of the year were investigated and are attributed to sample handling error. No comment has been made about the recent exceedance of the limit in June. In addition to the final discharge shown in Figure 11, there are two further discharge pipes (at different levels) from south west corner of the pond 4 - discharge from which is not monitored. The lower pipe is at a similar level to the main outflow. This discharge is to a mangrove area within the HOPL boundary. It is noted that the ponds have been subject wilful damage by third parties. Following such an incident in April 2010, the contents of the pond were discharged to the sea.

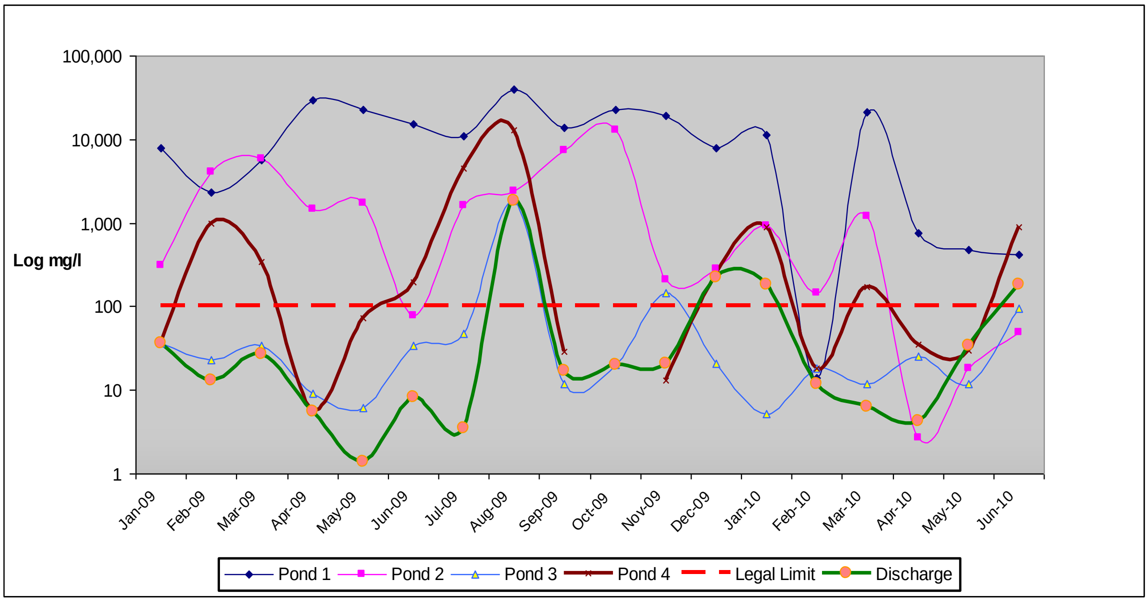
Figure 11
Pond layout



A sea wall was constructed relatively recently to protect the westerly pond walls from wave action, and the land built up with boiler ash. The initial RSPO certification assessment (September 2008) noted that clean-up plans for the ponds were yet to be formalised. Some actions have been taken such as the increased recirculation that has encouraged mixing promoting rates of microbial digestion, purchase of equipment to measure BOD and purchase of an aerator. There is no record of desludging but it is stated that all ponds have been desludged from time to time. A budget has been approved for pond modifications in 2011.

To allay concerns over the possible impact of pond discharges to the Bismark Sea, HOPL is in the process of commissioning a study from James Cook University. The study will examine local marine currents, water quality parameters and flora and fauna. The results from this investigation will be used to shape the 2011 pond modification plans.

Figure 12
BOD reduction in pond sequence



Note – the influence of seawater dilution is shown by comparing BOD concentration between the discharge and Pond 4.

Photos 6 & 7
Vegetation on Pond 2 & unmonitored discharge pipe

5.3.2 Navo Mill

Navo Mill is located 50 km east of Bialla town. It was commissioned in October 2002 with milling capacity of 45t/hr. Three treatment ponds receive effluent from the mill for partial treatment and field-based composting or discharge to a fourth pond located on the opposite side of the compost site. All three ponds are connected to an irrigation system that supplies POME to EFB in windrows. When not required for composting, effluent is discharged to pond 4 where it is applied to plantation land. The three ponds are in series. Analysis of monitoring data shows the BOD and temperature to be similar in three ponds showing that each fulfil primary treatment.

During the site visit pond 4 was covered by a thick blanket of matter (see photo 8). Monitoring data for the past year and a half show that the BOD quality of effluent sent to the nearby plantation is consistently below the 5,000mg/l limit. But that for 24 out of the 28 weeks of most recent data, the limit for total suspended solids was exceeded often significantly and once by a factor of ten. Over the same period the reported concentration oil & grease ranged from 2mg/l to 52,000mg/l with 45 samples out of 53 exceeding the 50mg/l criteria given in the Environmental Code of Practice. This might lead to excessive local nutrient supply, blockage of trenches intended to disperse treated effluent to groundwater and localised topsoil erosion. During the site visit the irrigation system was out of control and a stream of treated effluent (see photo 9) was flowing through the plantation onto a plantation road and ultimately to the Kianga Creek[40.] Following subsequent inquiry, it was stated that there are irrigation trenches over a 30ha area so this was probably a temporary operational issue. Further irrigation ditches are planned over an area of 90ha. These ditches will replace the original irrigation system that used polypipe laid under the frond stack[41].

There are plans to close the composting operation and send all treated effluent to irrigation.

[40] The Navo mill Environmental Permit states that effluent from the mill should not impact on the water quality of the Kianga Creek. During site visit there was no evidence to demonstrate that this has been assessed.
[41] These polypipes were continually cut by unknown persons; a trench-based system will remove possibility.

Photos 8 & 9
Pond 4 and treated effluent stream

Box 3 **Fishing**
During the consultations undertaken as part of this study the issue of fish kills due the discharge of mill effluent was raised. One incident had been investigated by one of the milling companies under its grievance procedure. Following investigation it was found to have no link to effluent. The use of the native Derris vine has been used to kill prawns and fish in streams, rivers and the sea. Recently there has been a trend to use 'Karate' (lambda cyalohathrin) for the same purpose. Simple inquiry in the markets in the Bialla area found women selling this powerful insecticide in 2 and 5 kina containers. It is suspected that it comes from a supplier in Kimbe. No inquiries about its availability were made in other SADP project areas.

5.4 *Oro*

The Popondetta area was hit by cyclone Guba in November 2007 with the torrential rain causing extensive damage to infrastructure. Much of this damage to roads and bridges is still to be repaired which has an on-going impact on FFB supply (amongst other things).

There are currently three mills in the Oro project area: Sangara, Mambo and Sumbaripa. Estimates of FFB production have not been provided for this study. Data for the FFB milled in the past four and a half years is given in Table 6.

Table 6
FFB milled in Oro Project area (t)

Year	Sangara	Sumbaripa	Mamba
2006	298,258	-	-
2007	332,627	-	-
2008	286,063	Commissioned (November)	Not commissioned
2009	183,274	96,224	34,516
2010 (to June)	120,199	45,850	26,136

5.4.1 *Sangara Mill*

The mill was constructed in 1976 (commissioned in 1980) in a low-lying area with a capacity of 30t/hr and upgraded to 60t/hr in the 1980s, has been rated at 75t/hr but for NBPOL's purposes it is a 60t/hr mill. At this time discharges were controlled by the Water Resource Act 1982 and treatment ponds were installed. Discharges from the ponds flowed to the Ambogo River, 0.6km from the mill. The river flows into Oro Bay.

In the 80s, owing to market conditions, resources were limited for mill and pond maintenance. A consequence was complete failure of the biological processes in the treatment ponds – exaggerated by significant oil losses – it reported that the smell at the time was bad. Given that milling continued the situation was compounded and the mill may have contributed to pollution of the River Ambogo. Local water users complained of 'itchy' skin and subsequently about excessive sedimentation killing aquatic fauna and changing the physical nature of the river.

In the early 90s DEC ordered the company to stop discharges to the River Ambogo and make improvements. At the same time the World Bank was designing the Oro Smallholder Oil Palm Development Project and secured a commitment from the Company to improve performance. The immediate solution was to build a series of dams in naturally occurring gullies west of the mill – some 1.7km from the Ambogo River. After filling, these gullies were operated on the concept of recirculation from pond 5 to pond 1, with the hope of volume reduction through loss to atmosphere (evaporation) or possibly infiltration. In 2001 composting was introduced. Land adjacent to Pond 2 was allocated to field composting EFB with POME. With time supply exceeded demand so compost was stockpiled leading to an explosion in the local rat population.

This activity has now stopped but the site has not been tidied up. During the site visit there was an abnormally large number of kites (birds of prey) present suggesting that the rat population is still numerous.

In 2007 land irrigation was introduced initially using a sprinkler system. This is reported to have scorched plantation cover crop probably owing to inadequate POME treatment. The current operation uses a trench system for irrigation (see bottom right photo on cover of this report).

The treatment system is listed as consisting of one cooling pond, 2 anaerobic ponds, 2 ponds referred to as aerobic and the polishing ponds (the 5 gulley ponds). One of the ponds adjacent to the mill receives storm drainage pumped from the mill site – the ponds are elevated some 2m above the grade of the mill. Effluent from the millponds is pumped 1km up an elevation of some 7m to the gully ponds, which are listed as having a capacity of 8,000m^3 a little less than one of the anaerobic ponds - they appear larger (see Figure 13). The drop from pond 1 to 5 is some 16m. An atypical feature is the extensive mat of vegetation in the middle sections of the pond sequence (see photo 12).

Despite limited attention given to the pond system, the treated effluent pumped from Pond 5 for irrigation has been well below the BOD limit for land application. Company site plans suggest that environmental monitoring takes place but these data were not available for this study. The site permit states that 144,000m^3 of treated effluent can be discharged to land application each year, not exceeding 16 hours per day or 25 days per month. Based on 2008 milling records using the factor of 1 tonne FFB processed to 0.7m^3 POME generated, this limit was exceeded by 54,000m^3, adding to the volume of water in the gully and placing hydraulic strain on the gully pond dams that seem to be exceeding the 'norm' (this applies especially to Pond 1). This observation is made on the basis of the effluent impinging vegetation on gully edges (see photo 11) and submersion of the sign notifying Pond 1 (see photo 13). The term norm is used owing to the nature and history of the gulley ponds – for typical excavated ponds there would be an engineered capacity that is the threshold before flooding occurs.

A report commissioned in 2006 by CELCOR *Impacts of Oil Palm Activities in the Kokoda and Popondetta Catchments - An Initial Environmental Examination'* suggested that the Sangara Mill POME treatment system is incapable of handling heavy rainfall and that in these circumstances treated effluent from the ponds still flows to the River Ambogo. It is not clear from site visit if this suggestion is reasonable. To support this suggestion, the report shows a photograph of a plume from a discharge point into the River Ambogo (shown in Figure 13). There is no reason to conclude that this is from the ponds, another possible explanation might be sediment flowing from storm drainage. It is noted that the aims of this 2006 *'were to identify issues and to determine priorities for an environmental impact assessment (EIA) and evaluate whether available data could support legal action*'. The report concluded '*Further scientific studies are unlikely to support a compensation claim against the HOPPL [Sangara] mill'*

It is recommended that the pond treatment system is thoroughly investigated giving initial focus to understanding the hydraulic regime, improving the efficiency of mill pond operation and seeking to reduce the volume of water in the gully ponds. This will present the opportunity to demonstrate that there are no environmental risks associated with the Sangara effluent management system.

Photos 11, 12 & 13
Gully ponds Impact on vegetation, mat of vegetation & effluent level above based of pond signage

Box 4
Sangara Mill and general water quality in the region

There has been a history of concern expressed about POME discharges from the Sangara Mill and the potential impact on the River Ambogo and some local creeks since the mill was established. During the course of this effluent study little written documentation was available to examine the issue, verbal comment appeared partisan and many of those with historical knowledge no longer work for Higaturu. One of the documents available is a study completed for CELCOR and the Ahora/Kakandetta People's Foundation by Cole and Craven '*Impacts of Oil Palm Activities in the Kokoda and Popondetta Catchments- An Initial Environmental Examination'* (IEE) February-March 2006 (see main text for background to this report). It found reduced water quality in the Ambogo River and Seiha Creek. POME is suggested as one of the contributors; the others included sewage, the Popondetta and mill rubbish dumps, the timber mill (which uses Copper Chrome Arsenate [highly toxic to aquatic life] as a timber preservative herbicide and pesticide use and topsoil run off causing extensive sedimentation. With respect to POME the IEE suggests that '*in the past when POME had no treatment the waterways would have been heavily impacted'.* Since commissioning the gully ponds, initially recirculation and subsequently irrigation and a trench system, the possibility of heavily impacting waterways during normal operation has been removed.

The Ahora/Kakandetta pressure group started to mobilise in 2000, this is one of the prominent groupings in Oro Community Environmental Action Group that has communication with CELCOR. Its main grievances concerned water and environmental pollution in the Seiha Creek (some 5km north east of the mill) from the Ambogo plantation, which flows through the Ahora village (see Figure 14). A further concern was run-off from the Sangara plantation and millponds into the Ambogo River. During preparation of this study an attempt was made to meet with Mr Andrew Mamako formerly the driving force behind this group and a highly respected member of the community, unfortunately he had recently passed away

HOP has on a number of occasions taken members of the local community and political representatives around its facility, as well as undertaking environmental awareness programmes in the local schools and larger community.

Communication with the Ahora community and travelling in the area shows that there are areas where the water quality appears contaminated. This appears to be a chronic issue and it is unlikely that today it can be substantially attributed to the Sangara mill. The Popondetta area has a growing population and inadequate sanitation* and waste disposal facilities; there is a long history of plantations with associated issues of fertiliser/agrochemical/EFB application and top soil loss and other sources of industrial pollution (notably a timber mill where use of hazardous preservation chemicals is likely). This will impact on the utility gained by the local community from clean water; however, they may be a contributory factor by using strong cleaning chemicals in the rivers and creeks (empty bottles of bleach were seen during a visit to Seiha Creek together with obvious sedimentation from top soil runoff). Photos 14, 15 & 16 show respectively milky standing water in the vicinity of Ahora, soap suds and an empty packet of soap powder (empty bleach bottles were also present) at Seiha Creek

* It is noted that when the previous environmental manager was in position, percolating filter sewage treatment was installed for properties in the mill compound. This was a major development as the majority of sewage in the area goes to septic tank.

Photos 14, 15 & 16
Seiha Creek and environs

Figure 13
Sangara ponds

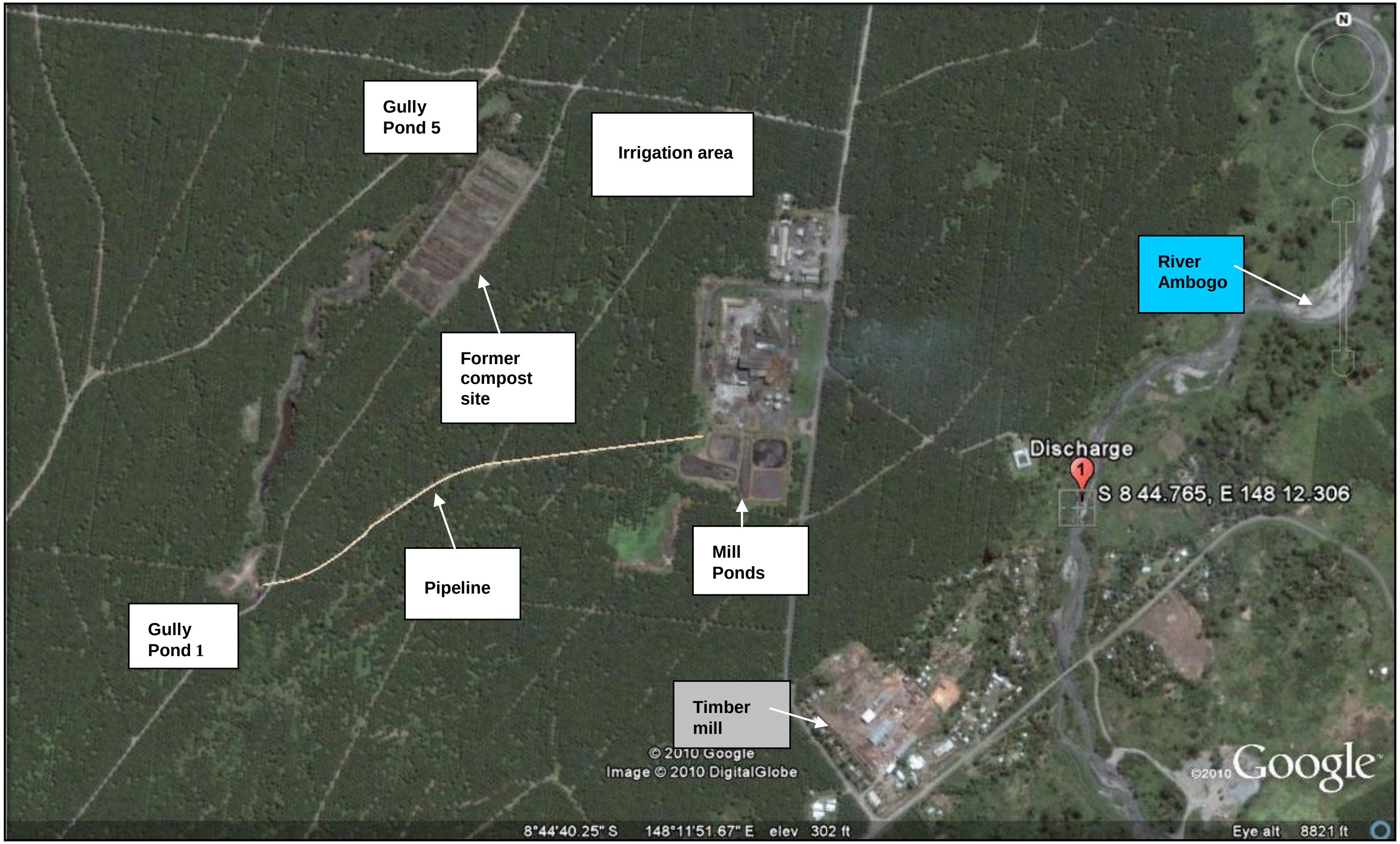


Figure 14
Sangara ponds and the environs

5.4.2 Sumbaripa Mill

The Sumbaripa Mill was commissioned in late 2007 and started milling in November 2008, it is a more modern design and instead of batch sterilisation has two continuous sterilisers. These fulfil the same function as batch sterilisers but without the need for cages or transportation vessels to hold the fruit. The condensate is generally recycled into the system reducing POME production.

There are nine ponds consisting of two parallel sequences - raw effluent pond, mixing pond, anaerobic pond and aerobic pond in parallel, and pond 9 a sedimentation pond from where treated effluent is to be discharged to trenches in the nearby plantation. At the time of site visit the irrigation system was not completed. Since commissioning one sequence of ponds has been filled, and excess effluent has been pumped into the empty ponds to avoid flooding. The monitoring data provided are difficult to follow but suggest that the control parameters are well below the limits for land application. The site permit states that 280,000m^3 of treated effluent can be discharged to land application each year, not exceeding 16 hours per day or 25 days per month.

Photo 17
Evidence of previous flooding & oil in the effluent

5.4.3 Mamba Mill

The Mamba Mill was commissioned in April 2009, it is a more modern design and instead of batch sterilisation has two continuous sterilisers. The condensate is generally recycled into the process. At the time of site visit the mill had been working half time owing to shortages of FFB supply. The lack of supply is related to the still to be repaired road and bridge infrastructure.

The mill has a design capacity of 25t/hr with a pond system designed for future mill expansion to 45t/hr. These ponds have an HDPE liner as shown in Photo 18. The specification for a liner was made by Cargill management owing the proximity and number of very high quality surface watercourses, and the porosity of the soils. The edges of the liner are exposed to sunlight and will degrade in the medium term due to exposure to UV light unless protected.

Treated effluent from the pond is pumped for land application in the nearby Komo division of the Mamba plantation. The treated effluent is piped to a series of 64 trenches, 32 each side of a central flow. As at the other mills, filling is a manual operation. Given the depth of the trenches this is disposal of excess water to groundwater. Pond operators noted that the effluent was treated to a sufficiently high standard that it has no nutrient value for irrigation and is of no interest to plantation managers. No discharge data were available to review.

During early pond operation biological processes were poorly managed/understood. Consequently there was little or no POME breakdown leading to a build up of solids (jokingly it was suggested that it was possible to walk across them). This was reported as a non-conformance in the EMS and mitigation actions were taken. This included the addition of 'MB1000' that was said to be a strain of super bacteria[42]. Unlike many of the other ponds visited in this study very little odour was observed. The site permit states that 480,000m^3 of treated effluent can be discharged to land application each year, not exceeding 16 hours per day or 25 days per month.

Site drainage is collected in concrete lined drains flowing around site perimeter. The flow passes through two grease traps before passing to a sludge pit from where it is pumped to the ponds and surface oil recovered.

Photo 18
Lined final settling pond at Mamba

[42] A product called MB 1000 is sold as a broad-spectrum microbiocide for the control of algae, bacteria and fungi.

6 Summary and conclusions

All FFB milling is controlled and managed by two private companies that currently operate as three commercial ventures: NBPOL, HOPL and KPOL trading as Higaturu Oil Palm.

Table 7
Summary of approaches to POME management

Mill	Operator	Commissioned	POME management
Mosa	NBPOL	1972	Treatment for discharge to surface water. Plans for methane recovery pond
Kumbango	NBPOL	1981	Treatment for discharge to surface water Plans for methane recovery pond
Kapiura	NBPOL	1990	Treatment for discharge to surface water Plans for methane recovery pond
Numundo	NBPOL	2001	Split treatment - discharge to surface water, and a proportion used for EFB composting. Plans for methane recovery pond
Waraston	NBPOL	2011	Treatment for discharge to surface water Plans for methane recovery pond
Hargy	HOPL	1970s	Treatment for discharge to sea Plans for methane recovery pond
Navo	HOPL	2002	Split treatment for EFB composting & excess for discharge to land Plans for methane recovery pond Composting to be abandoned
Barema	HOPL	2012	Plans for methane recovery pond Treatment for discharge to surface water
Sangara	HOP	1980	Treatment & discharge to land at this time. Future intention for methane recovery pond.
Sumbaripa	HOP	2007	Treatment & discharge to land. Future intention is for methane recovery pond.
Mamba	HOP	2008	Treatment & discharge to land for fertiliser replacement.

Despite the possible opportunities, POME is still a large end of process waste requiring management. In recent history the approach to POME has changed from being viewed as a waste to be disposed of, to becoming part of business revenue. This has been driven by regulation, commercial opportunity, management tools and voluntary initiatives by the industry. Significant progress in fostering and implementing change has been aided by the adoption of both ISO 14001 and RSPO principles and criteria. All the mills in New Britain are certified to these standards and it is stated that operations in Oro will be certified following the take over by NBPOL. Certification should mean that systems are in place to ensure POME management complies with legal requirements through the adoption of best practices. Where it does not, companies run the risk of loosing their certified status following annual third party audits. Given that producers in Papua New Guinea seek to distinguish their product in the marketplace on the basis of its sustainability, loss of RSPO certification would be a serious matter.

In the past the Department for Environment and Conservation (DEC) has driven improved POME management practices where there has been gross pollution. However national regulation is not robust so the effective privatisation of regulation through third party certification is a positive initiative that should ensure POME management consistent with World Bank policies. Although some community based stakeholders have reservations about the impartiality of third party certification as it is the companies that ultimately pay for the audits.

The study showed that most if not all mills are legally compliant. A categorical statement about full legal compliance for all mills is not made because the issuing of permits is going through a transitional phase, permits are not always clear, environmental performance data were not always available and the constraints associated with study preparation. In addition there are issues concerning data quality – selected comparison between internal monitoring results and analyses made by the National Analytical Laboratory show marked differences.

The modern mills are more readily equipped to manage POME with minimal environmental risk given their design, location and available space. Mosa, Hargy and Sangara mills present greater environmental risk: Mosa due to the proximity of the ponds to a river; Hargy because of its low lying status, proximity to the sea and space constraints, and Sangara because of its low lying status, history and the unique nature of treatment system. A number of operational issues were identified during site visits with appropriate attention and with technical consideration these can be addressed. ISO 14001 has a training and competency element that ought to ensure the number of such issues is minimised in the future. NBPOL is taking a positive step to enhance its technical pond management capabilities by employing a pond specialist.

The terms of reference for this study request that current and historic health issues associated with POME are investigated. On the basis of the work completed and the current effluent management infrastructure, there is no reason to believe any health issues can be attributed to contemporary operations. Historically it is probable that poorly controlled effluent releases from the Sangara Mill did impact upon the well-being of the local community. These releases would have added to other factors such as: inadequate provision of sanitation, inadequate waste management infrastructure, effluent from a nearby timber mill and impacts associated with plantations. Many of these factors remain or are being compounded by an increase in local population and possibly the area of land cultivated for oil palm.

6.1 Conclusion

The Effluent study terms of reference asked if the palm oil milling companies in the SADP project areas have the capacity in their mills to adequately treat the increase in POME anticipated due to the SADP. This study interprets ‘capacity’ as: sufficient infrastructure to manage and treat POME to adequate standards prior to final use or disposal; adequate sampling and monitoring to demonstrate treatment to these standards, and management practices, capability and controls to ensure adequate environmental performance.

Study preparation has shown that: some sites have experienced operational issues that have influenced discharge performance; there are challenges with the quality of regulatory monitoring data and that the definition of full-compliance could be more precise. However given that all the mills are or will shortly be certified to ISO 14001 and RSPO principles and criteria, which have commitments for continuous improvement, the necessary practices, capabilities and controls should be in place to treat the increase in POME due to the SADP.

To give the World Bank the necessary assurance that the SADP POME is adequately managed (and that adequate management is more precisely defined) the following is recommended:

(i) The industry uses the proposed updating of the PNG Environmental Code of Practice for the Oil Palm Processing Industry as a means to; improve the quality and scope of effluent related environmental monitoring, provide greater guidance on the design and operation of POME treatment systems, and give more definition to 'targets' and 'limits' for discharge of treated POME to land and surface waters. This might include: establishing accepted monitoring frequency, defining full-compliance to standard (i.e. strict application to limit values or assessment on a percentile basis to allow for abnormal circumstances), developing pragmatic limits for discharges to water (terrestrial & marine) for oil and grease and total suspended solids, and determining guidance and limits for the application of pond sludge to land and nutrient discharge to the aquatic environment.

    It is recommended that the participatory approach between the industry and DEC in updating Environmental Code is continued and that the current informal relationship between the Code and government regulation is formalised. This should help accommodate resources constraints experienced by DEC and help overcome the challenges associated with monitoring data.

(ii) HOPL issues and implements an improvement plan which documents mill effluent management practices that includes; results from the study examining the potential impact of POME discharges on the Bismark Sea, describes the actions to improve pond performance at the Hargy Mill, and describes planned changes to POME treatment and management at the Navo Mill.

(iii) HOP makes a thorough investigation of the POME treatment and site drainage at Sangara mill. The objective will be to obtain greater understanding of the system, more readily respond to accusations that mill effluent has deleterious environmental impacts, reduce the volume of water in the gully ponds, and ensure adequate environmental performance. As part of the review process for this study, HOP has committed to a thorough investigation as part of its continuous improvement plan for the operation.

Appendix 1
Meetings held during study preparation

Person	Job Title	Organisation
Wednesday 14 July (Port Moresby)		
Erik Johnson	Acting Country Manager	World Bank, Port Moresby (POM)
Mike Scott	Programme Manager SADP	Oil Palm Industries Association (OPIC)
Ian Orell	Head	Oil Palm Research Association (OPRA)
Ms Kay Kalim	Acting Deputy Secretary	Department of Environment and Conservation
Eddie Tanago, Paula Nato, Eddlebert Gangai	Campaigner, Legal Specialist, Spokesperson for Forest Land Rights	CELCOR – Centre for Environmental Law Forest Land Rights (19 community groups from the Oro Community Environmental Action Group)
Dr John Duguman	Head of Environmental Science	University of Port Moresby
Thursday 15th July (West New Britain, Hoskins)		
John Hulo	Environment Officer (Hoskins)	OPIC Kimbe WNB (John Hulo accompanied the report author to all the mills)
Steven Oiza	OPIC Project Manager (Hoskins)	OPIC Kimbe
Ian Rove Sahato	Environment Officer	Part of Sustainability Team at New Britain Palm Oil Ltd. (NBPOL)
Aruldass Williams	Deputy Head of Engineering	NBPOL
Daniel Kolinjim	Laboratory Superintendent	NBPOL
John	Mill Engineer	NBPOL
Visit Mosa Mill & ponds		
Friday 16th July (West New Britain, Hoskins)		
Chris Kisip	Mill Engineer	NBPOL
Cedric Moses	Mill Engineer	NBPOL
Ian Rove Sahato	Environment Officer	NBPOL
Visit Kumbango Mill & ponds		
Saturday 17th July (West New Britain, Hoskins)		
Ian Rove Sahato	Environmental Officer	NBPOL
Thomas Betitis	Soil Scientist	NBPOL
Monday 19th July (West New Britain, Bialla)		
Kerry Tabom	Mill Manager Kapiura	NBPOL
Visit Kapiura ponds		
Travel to Bialla and subsequent meetings in Bialla		
Otto Pakam	OPIC Project Manager	OPIC Bialla
Florence Jiki	OPIC Environment Officer	OPIC Bialla
	Representative	Bialla Smallholders
Max Kudik	Sustainability Manager	HOPL
Visit Hargy ponds		
Tuesday 20th July (West New Britain, Bialla)		
Graham King	General Manager	HOPL
Max Kuduk	Sustainability Manager	HOPL
Patrick Warbongoi	Mill Maintenance Manager	HOPL
Eddie Dawan	Process Superintendent	HOPL

Steven Fuame	Lab Supervisor	HOPL
Visit Navo ponds		
Wednesday 21st July (West New Britain, Hoskins)		
Roger Crawford	Sustainability Manager	NBPOL
John	Mill Manager Numundo	NBPOL
Visit Numundo ponds		
Thursday 22nd July (West New Britain, Hoskins)		
Jeff Logan	CDM Pond Manager	NBPOL
Friday 23rd July (Oro, Popodetta)		
Simon Lord	Sustainability Director	NBPOL
Petra Meekers	Regional Sustainability Manager	NBPOL
William Griffiths	Operations Manager	NBPOL
Saturday 24th July (Oro, Popondetta)		
Simon Lord	Sustainability Director	NBPOL
Petra Meekers	Regional Sustainability Manager	NBPOL
William Griffiths	Operations Manager	NBPOL
Ratnan Somooo	General Manager	Kula Palm Oil Ltd.
Paul Maliou	Sustainability Manager	Kula Palm Oil Ltd.
Visited Sangara Mill & ponds with Simon Lord and William Griffiths		
Sunday 25th July (Oro, Popondetta)		
Marjory Hamasa	Principal representative	Ahora village
Monday 26th July (Oro, Popondetta)		
Roger Irurapa	SADP Land Officer	OPIC Popondetta
Kepa Kemilio	SADP Environment Officer	OPIC Popondetta
Paul Maliou	Sustainability Manager	Kula Palm Oil Ltd.
Henry Suica	Acting Mamba Mill Manager	Kula Palm Oil Ltd.
K R Garapathy	Estate Field Manager Mamba	HOP (Kula Palm Oil Ltd.)
Visited Mamba Mill & ponds		
Tuesday 27th July (Oro, Popondetta)		
Henry Suica	Mill Manager Sumbaripa	HOP (Kula Palm Oil Ltd.)
Ratnan Somooo	General Manager	HOP (Kula Palm Oil Ltd.)
Paul Maliou	Sustainability Manager	HOP (Kula Palm Oil Ltd.)
William Andrew	Laboratory Superintendent	HOP (Kula Palm Oil Ltd.)
Justin		HOP (Kula Palm Oil Ltd.)
Visited Sumbaripa Mill & ponds		

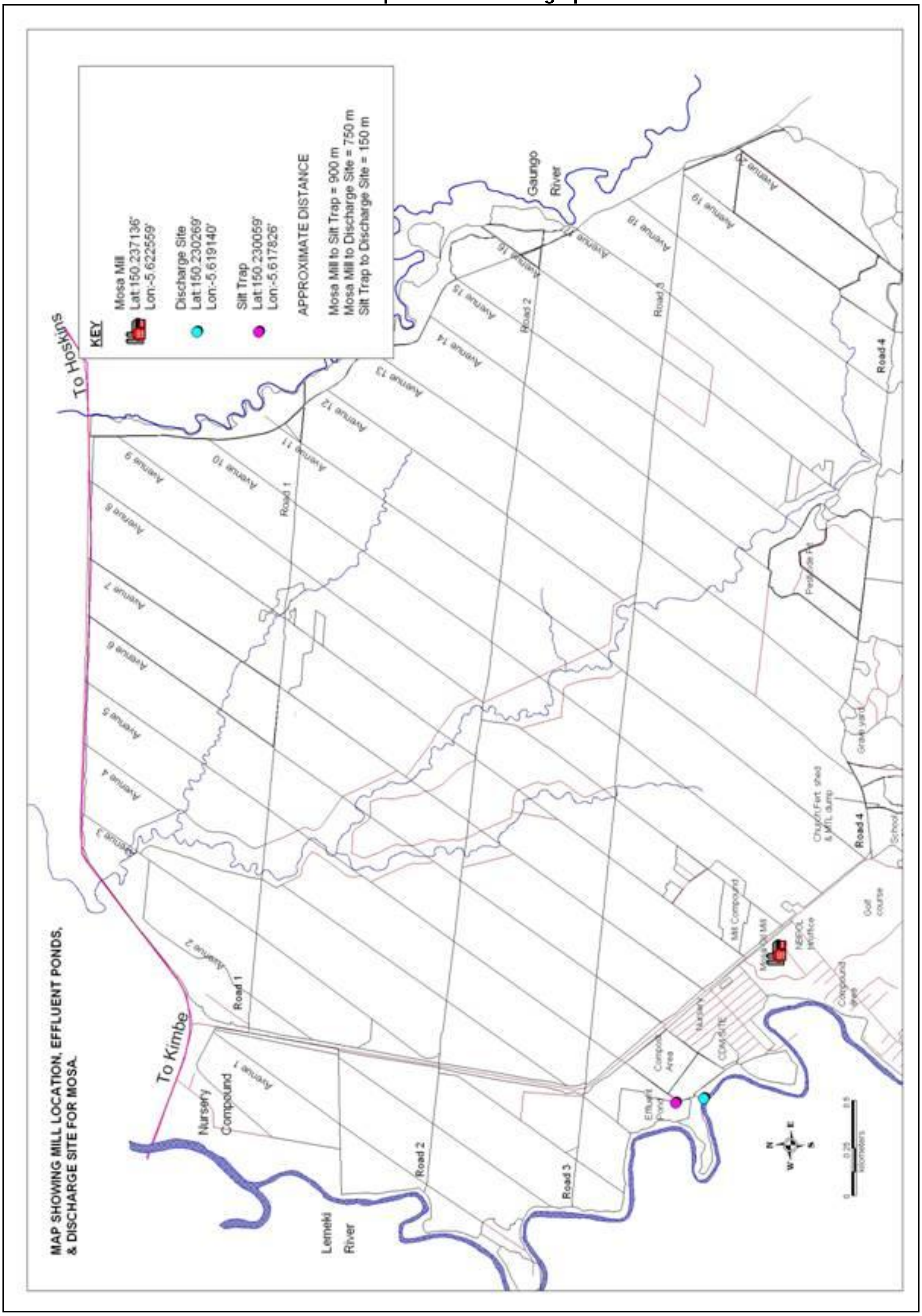
Appendix 2
Generic RSPO Principles and Criteria
(abridged and most applicable to the Effluent Study)
PNG interpretation found on RSPO website

Principle 1: Commitment to transparency	
Criterion 1.1 Oil palm growers and millers provide adequate information to other stakeholders on environmental, social and legal issues relevant to RSPO Criteria, in appropriate languages & forms to allow for effective participation in decision making.	Indicators: Records of requests and responses must be maintained.
Criterion 1.2 Management documents are publicly available, except where this is prevented by commercial confidentiality or where disclosure of information would result in negative environmental or social outcomes.	Indicators: Documents that must be publicly available include, but are not necessarily limited to: • Plans and impact assessments relating to environmental and social impacts (5.1, 6.1, 7.1, 7.3). • Pollution prevention plans (5.6). • Details of complaints and grievances (6.3). • Continuous improvement plan (8.1).
Principle 2: Compliance with applicable laws and regulations	
Criterion 2.1 There is compliance with all applicable local, national and ratified international laws and regulations.	Indicators: • Evidence of compliance with relevant legal requirements. • A documented system, which includes written information on legal requirements. • A mechanism for ensuring that they are implemented.
Principle 4: Use of appropriate best practices by growers and millers	
Criterion 4.1 Operating procedures are appropriately documented and consistently implemented and monitored	Indicators: • Standard Operating Procedures are documented • Records of monitoring & the actions taken are maintained.
Criterion 4.2 Practices maintain soil fertility at, or where possible improve soil fertility to, a level that ensures optimal and sustained yield.	Indicators: • Records of fertilizer inputs are maintained. • Evidence of periodic tissue and soil sampling to monitor changes in nutrient status. • A nutrient recycling strategy should be in place.
Criterion 4.4 Practices maintain the quality and availability of surface and ground water.	Indicators: • An implemented water management plan. • Protection of water courses and wetlands. • Monitoring of effluent BOD. • Monitoring of mill water use per tonne of FFB .
Criterion 4.7 An occupational health and safety plan is documented, effectively communicated and implemented.	
Criterion 4.8 All staff, workers, smallholders and contractors are appropriately trained.	Indicators: • A formal training programme that includes regular assessment of training needs and documentation of the programme. • Records of training for each employee are kept.
Principle 5: Environmental responsibility and conservation of natural resources and biodiversity	
Criterion 5.1 Aspects of plantation and mill management, including replanting, that have environmental impacts are identified, and plans to mitigate the negative impacts and promote the positive ones are made, implemented and	Indicators: • Documented impact assessment. • Where the identification of impacts requires changes in current practices, in order to mitigate negative effects, a

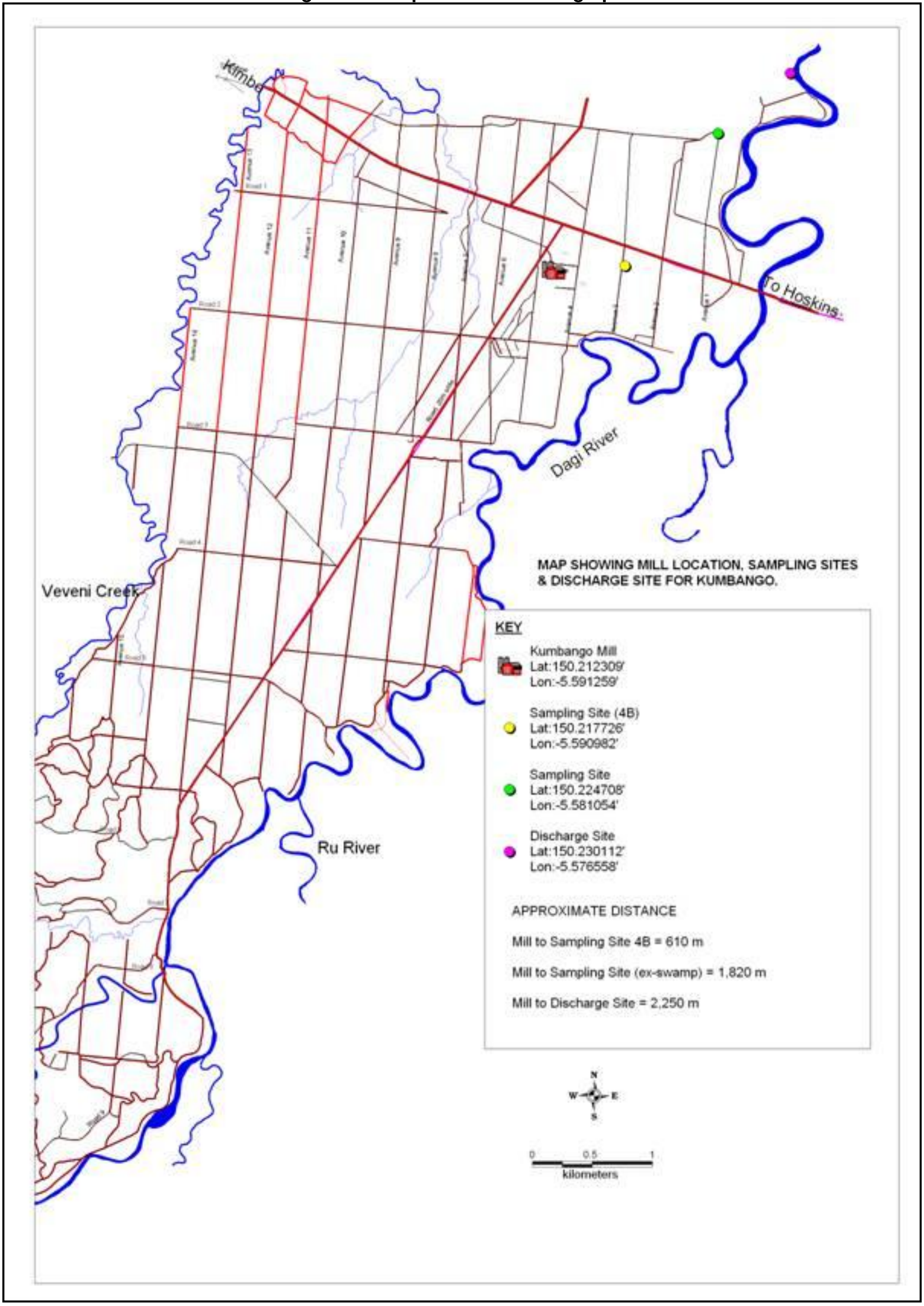
monitored, to demonstrate continuous improvement.	timetable for change should be developed.

Criterion 5.2 The status of rare, threatened or endangered species and high conservation value habitats, if any, ….. could be affected by plantation or mill management, shall be identified and their conservation taken into account in management plans and operations.	
Criterion 5.3 Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner.	Indicators: • Documented identification of all waste products and sources of pollution • Having identified wastes, a waste management and disposal plan must be developed and implemented.
Criterion 5.4 Efficiency of energy use and use of renewable energy is maximised.	Indicators: • Monitoring of renewable energy use per tonne of CPO or palm product in the mill. • Monitoring of direct fossil fuel use per ton of CPO (or FFB where the grower has no mill).
Criterion 5.6 Plans to reduce pollution and emissions, including greenhouse gases, are developed, implemented and monitored.	Indicators: • An assessment of all polluting activities must be conducted, including gaseous emissions, particulate/soot emissions and effluent (see also criterion 4.4). • Significant pollutants and emissions must be identified and plans to reduce them implemented. • A monitoring system must be in place for these significant pollutants which goes beyond national compliance. • The treatment methodology for POME is recorded.
Principle 6: Responsible consideration of employees and of individuals and communities affected by growers and mills	
Criterion 6.1 Aspects of plantation and mill management, including replanting, that have social impacts are identified in a participatory way, and plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement.	Indicators: Guidance: Potential social impacts may result from activities such as: building new roads, processing mills or other infrastructure;
Principle 8: Commitment to continuous improvement in key areas of activity	
Criterion 8.1 Growers and millers regularly monitor and review their activities and develop and implement action plans that allow demonstrable continuous improvement in key operations.	Indicators: • The action plan for continual improvement should be based on a consideration of the main social and environmental impacts and opportunities of the grower/mill.

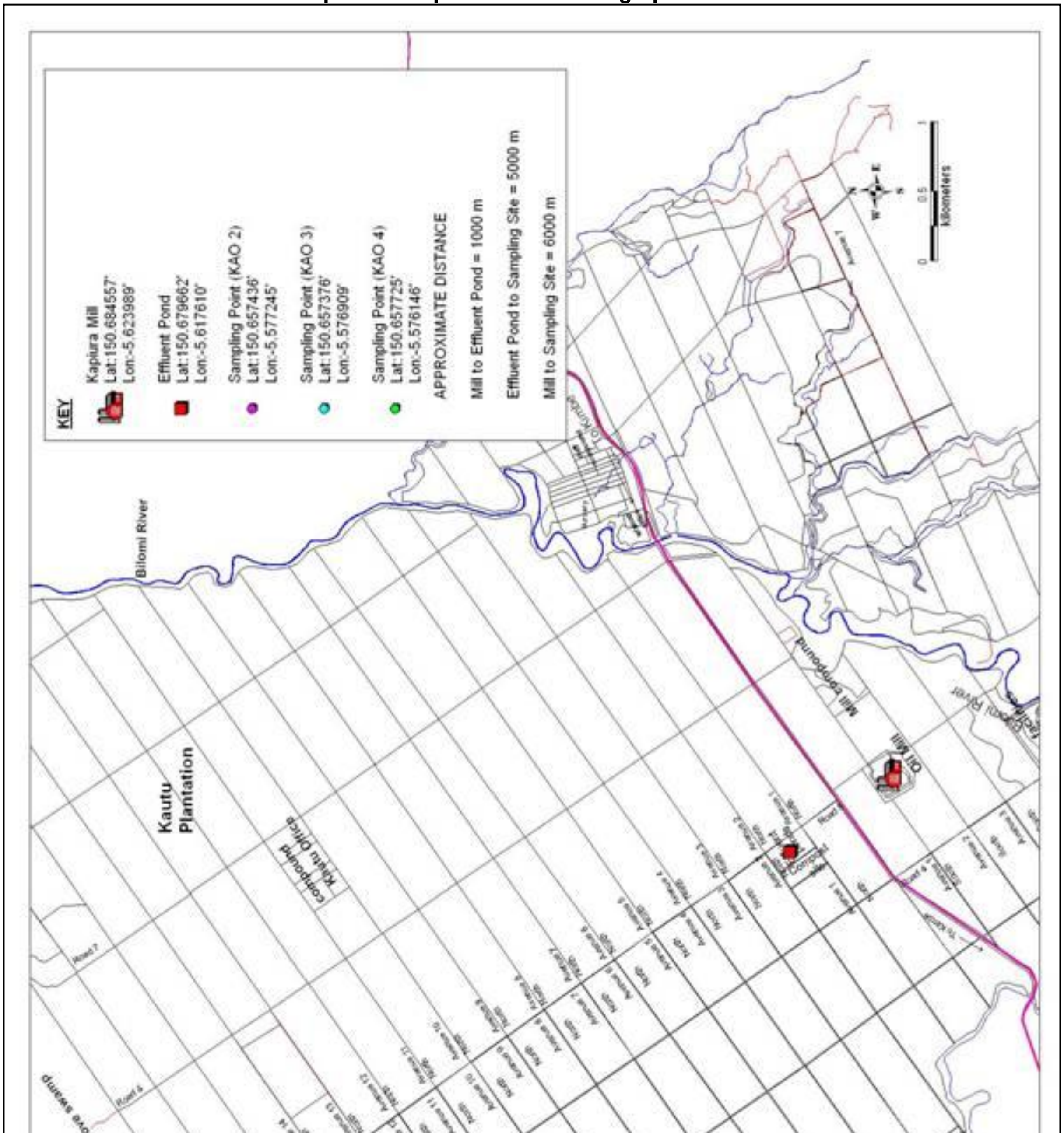
Appendix 3
Mosa Mill site plan and discharge point



Appendix 4
Kumbango Mill site plan and discharge point



Appendix 5
Kapiura site plan and discharge point



Appendix 6
Numundo site plan and discharge point