Proposed Biomass Power Station Palings Rd Manjimup
(EPA Assessment 1707)
Connell Wagner addendum to PER 31/03/08

Stormwater Modelling and Proposed Management Options

Prepared on behalf of:

Western Australian Biomass Pty Ltd

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Queensland Laboratory Pty Ltd		Job No:	QIR070634
Telephone:	1300 138 366	File Reference:	Manjimup
Facsimile:	(07) 5578 5567	Date of Issue:	02/04/08
Email:	kevin@queenslandlab.com	Project Manager:	Kevin O'Hara

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Author(s):	Marc Walker, Kevin O'Hara
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Client Contact:	Praveen Mahto
Synopsis:	This report presents a response to the Department of Water comments on Connell Wagner addendum to PER 31/03/08 regarding the stormwater modelling and management for the proposed Biomass Power Station located on Palings Rd in Manjimup, WA (EPA Assessment 1707).

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1 INTRODUCTION

As previously discussed, Queensland Laboratory have been engaged by Western Australia Biomass Pty Ltd to help with some of the site stormwater issues recently raised by your department. In response to the comments made by the Department of Water (DoW) relating to the Connell Wagner addendum to PER 31/03/08, we have summarised the highlighted issues as per our conference discussion of the 9th of April 2008 below, and have endeavoured to address each issue accordingly. Note that calculations and design details are indicative only. They are intended to give an indication of required sizes of dams and runoff volumes.

2 CONSTRUCTION PHASE

For the purpose of this response Western Australia Biomass Pty Ltd would like to separate the construction and operational phases of the project and have flagged them as two separate issues. Whilst some overlapping of process will occur, a detailed construction phase management plan will ensure that all potential stormwater issues are adequately addressed and managed during the construction phase so as to eliminate the potential for stormwater contamination. This management will include the pre-works construction of a bunded area on which all plant, equipment and potential hydrocarbon sources will be stored.

3 STORMWATER MANAGEMENT

The results of the conference meeting and the DoW's responses to Connell Wagner's addendum report indicated that stormwater runoff quality, and therefore on-site stormwater management was a key issue.

During the operational phase of the project, management procedures will be adopted to ensure that contaminants do not make their way into the stormwater system. These procedures will include but not be limited to:

- bunding and where appropriate roofing hydrocarbon and chemical storage areas or storing these substances in-doors;
- diverting external stormwater runoff around the site before it contacts any potentially contaminated areas;
- maintaining closed loop systems for ash water and process water whereby all wastes are either recycled within the system or removed off-site for treatment and/or disposal;
- separating biomass stormwater runoff into a separate treatment / reuse system.

Hydrocarbon management will involve isolating these areas from the general stormwater system as noted above. Any water collected in these areas will be either removed off-site for treatment or passed through oil-water separators and the waste collected and taken off-site by licensed contractors. As such, management of this water is not further discussed here.

A water balance is presented in Attachment B which shows conceptually how the closed loop system for process and ash water systems is proposed to work. It also shows reuse volumes and pathways of plant and biomass area runoff water.

Isolating the biomass area involves directing stormwater runoff and leachate into a retention pond that is hydrologically separate from the remainder of the stormwater system. It is then proposed to reuse all of the water collected in dust suppression, ash wetting and as feed water to the RO/EDI treatment plant for polishing prior to use in the power plant.

4 PROJECTED STORMWATER RUNOFF AND PREDICTED RETENTION VOLUMES

Stormwater runoff across the site can be broadly separated into a number of distinct areas in terms of water management. These are:

- Biomass Yard area (2ha) and Feeder pile area (0.26ha) – medium risk runoff water from wood pile runoff and leachate water to be fully contained;
- Remainder of Feeder Pile Area south of the plant (1.5ha) – largely un-impacted lands generating low risk stormwater runoff; and
- Plant Area (1.6ha) – assumed fully sealed. Hydrologic separation of chemical and fuel areas results in generation of low risk stormwater runoff.

4.1 Design Storm

Calculations were performed on these areas to gauge the runoff volume resulting from a design storm event, the details of which are shown in Attachment A. Using no loss factor (to give a high conservative value), the maximum runoff volumes from a 1 in 10 year, 24 hour storm event were calculated as:

- Biomass yard and feeder pile medium risk stormwater to be fully contained = 1.7ML. With 25% proportional loss = 1.3ML;
- Remainder of Feeder Pile area south of plant = 1.1ML. With 25% proportional loss = 0.9ML
- Plant only area low risk stormwater = 1.2ML;

Therefore, a pond with a sediment settling volume in excess of 1.3ML would suffice to capture the entire stormwater runoff from the biomass and feeder stockpile areas from a 1 in 10 year 24 hour storm. Assuming the pond is half full, a settling volume of approximately 2.6ML is appropriate.

Similarly, a sediment pond in excess of 1.2ML for the Plant area, or around 2.4ML assuming the pond is half full, would be sufficient to completely capture the above storm event. However, since this is classed as low risk water a settling pond of smaller dimensions may be used. Assuming capture of course sediment only is required (as per sandy / gravely surface soils in the area), a sediment pond in the order of 100-200m^2 only is required[1].

It has previously been proposed to discharge water from this sediment basin via bioremediation controls to the receiving catchment. This assumes a hydrologic separation of more hazardous liquid waste. More detailed design to be undertaken at later stages will enable the actual volumes to be further refined based on less conservative estimates of infiltration and surface storage loss. Another option is to capture this water in a larger reservoir and re-use it as process or ash-wetting water.

[1] Based on Brisbane City Council's Sediment Basin Design, Construction and Maintenance Guidelines (January 2001).

4.2 Daily Water Balance Modelling – Overview

Daily water balance modelling was also performed utilising a simple surface storage capacity model. Rainfall was added on each day and evaporation subtracted from this store. Overflows from the soil / stockpile surface store were equated to runoff from the site. This runoff enters the pond and further overflows are generated as the pond overtops. While very simple, this model allows an overview of processes and an estimation of quantities to be made.

To better estimate required pond volumes, the biomass area and plant area runoff and their respective retention ponds were modelled together. The total daily demand was removed from the biomass pond first, and any remaining demand from the plant pond.

Modelling was undertaken based on rainfall and evaporation from Manjimup over the period 1 January 1974 to 31 March 2008[2]. Reducing the rainfall record to annual values over the 1974 to 2008 period, the following years were chosen for analysis of overflows from the pond:

- average years (1023mm ± 5%) – 1974, 1978, 1979, 1980, 1983, 1989, 1990, 1993, 1997;
- 90th percentile years (1174mm ± 5%) – 1981, 1984, 1999, 2003, 2005, 2007

4.3 Daily Water Balance Modelling – Biomass Area

Limited data is available in setting the surface storage depth for wood piles. Some data exists for surface mulches and coal stockpiles and a study by Curran *et* al (2002) for coal stockpiles noted an average infiltration of 22mm for rainfall intensities around 50mm/h over half an hour (excluding the higher rainfall intensity of 111mm/h). As an initial estimate, the surface storage capacity for the wood stockpile area was set at 20mm. Since only milled wood chips are stored on-site and factoring in the expected storage capacity in and on the surface of roads and working areas, this is expected to be a low estimate. To be sure, dust suppression volumes were not included in these estimates.

Initially, a pond area of 1300m^2 (equal to the existing spray pond area) was used with a depth of 2.7m (to capture the 1 in 10 year storm assuming no losses) and starting depth at half capacity. This capacity was increased until no overflows were observed, on average, for representative 90th percentile wet years.

While various measures exist to treat such runoff water, it is expected that the RO/EDI water treatment plant and the ash wetting process will be able to utilise this water. Utilising a total annual demand for ash wetting and process water of 23ML/yr extrapolates to, on average, 63kL/day.

Increasing the pond volume to 9ML (to an 1800m^2 surface area and 5m deep pond) reduced the number of overflows during representative 90th percentile years to 0. This does not include any use of the water for dust suppression on the site.

[2] Following advice on representative years from CSIRO Land and Water (pers.comm, April 2008) due to the decrease in rainfall experienced in Western Australia over the past several decades.

4.4 Daily Water Balance Modelling – Plant and Other Areas

Similar modelling was performed to that shown above to estimate runoff volumes from the Plant area and remaining feeder pile area (not impacted by the feeder pile itself). Average annual runoff volumes were generated at 10ML/yr for the Plant area with a 5mm surface storage capacity, and 8.2ML/yr from the remaining feeder pile area with a surface storage capacity of 15mm.

Results from the Plant-Biomass area coupled water balance model during average years indicated a pond size of 32.5ML (6500m^2 surface area at 5m depth) would be sufficient to eliminate overflows during average years. This utilises excess demand after water has been removed from the biomass retention pond.

However, it may be more practical to reduce the size of this dam, using some water for reuse and discharging the remainder. A suitable alternative may include treating and/or reusing the 1 in 3 month flows from the plant site and discharging higher flows. This approach would result in the treatment or reuse of approximately 90% of flows throughout the year.

4.5 Annual Water Balance

The results of the above water balance based on average climate years has been incorporated into an annual water balance for the site. Two scenarios were explored:

- Scenario 1 - total reuse of biomass runoff water in ash wetting and as input to the plant and discharge followed by treatment of plant runoff water;
- Scenario 2 – as above except incorporating a total reuse of the plant runoff water as well instead of discharge.

Both of the above scenarios involve supplanting WAPRES dam source water and the results, showing estimated annual runoff volumes and reuse volumes, are shown in Figures B1 and B2 in Attachment B.

5 WATER QUALITY

5.1 Water Quality of Biomass Runoff

Assuming around 85000m^3 of biomass is stored on the site covering approximately 75% of the fuel storage area, a significant portion of the stormwater is likely to be affected by leachate runoff from wood stockpiles. This is expected to contain a moderate to high Biological Oxygen Demand (100-1000mg/L), a low pH, relatively high Chemical Oxygen Demand, tannins and lignins, volatile fatty acids and low concentrations of nutrients (though this may be quite variable).

5.2 Discharge Water Quality from the site to Downstream Catchments

As discussed within the comments from the DoW, Western Australia Biomass Pty Ltd agrees that the release water quality parameters should be based on the background water quality currently perceived as acceptable to be discharged from the site. As the site slopes to the southwest, it is considered likely that the downstream catchment is the East Brook catchment which feeds into Lefroy Brook (below the Pemberton town water supply draw point).

The DoW has supplied a number of sites in the vicinity. Two of these are located in Lefroy Brook downstream of Pemberton and may represent a typical concentration range for the downstream catchment prior to its flow into the Warren River (classified by the DoW as a potential drinking water supply). Some sampling data is also available for the existing WAPRES dam on the site, taken as indicative of the current discharge quality from the site.

Another two DoW sites are located downstream of the WAPRES dam into the Lefroy Brook. Average values of key parameters from these sites are given in Table 1 below.

Examination of the full dataset will allow setting of percentile limits to off-site runoff or other statistics to the satisfaction of the administering authority(s). Using the appropriate sites as a background, the discharge water quality is limited to a quality the same or better than that found in the downstream waterway. This is also expected to result in a protection of future drinking water resources in the area.

Table 1: Indicative average values from Lefroy Brook sites (6070006 and 6071106) and WAPRES dam

Parameter	Unit	Lefroy Brook (site 6071106)	Lefroy Brook Tributaries (north west) (sites 6071031, 6071095)	WAPRES dam sample (1 occasion)
Colour	TCU or Hu	47.7	11.4	
BOD_5	mg/L		4.3	<5
Total N	mg/L	0.543	0.68	
Total P	mg/L	0.194	0.050	
Salinity	mg/L	240		
TDS	mg/L		394	250
Conductivity	mS/cm			0.41
Turbidity	NTU	5.4	7.6	
pH	(none)	7.3	6.9	7.1

6 CONCLUSION – CONCEPTUAL VIABILITY OF WATER MANAGEMENT STRATEGY

6.1 Water Retention and Treatment Capacity

6.1.1 Biomass Yard

From the results of water balance modelling is expected that it would be technically possible to build a catchment pond of sufficient capacity to capture the entire runoff from a 1 in 10 year, 24 hour storm, and to also result in no discharges during an average 90^{th} percentile rainfall year. The water balance diagrams in Attachment B show that there is adequate annual demand for this water and that the modelled daily demand may be a conservative estimate.

Daily water balance modelling shows that a pond surface area of $1800m^2$ and 5m deep and overall daily demand of 63kL will result in no overflows during representative 90th percentile wet years. Using a more conservative surface storage capacity of 5mm (rather than 20mm) resulted in only a small increase in required pond area from $1800m^2$ to $2100m^2$.

6.1.2 Plant Area

Due to the lower risk nature of stormwater from the plant area, it is considered sufficient to utilise a sediment capture basin designed to capture sediment of 0.02mm and courser in the order of 150 -$200m^2$ surface area. This can be followed by further treatment measures if required such as bioremediation devices to reduce nutrients and dissolved metals (via extended detention, vegetation, and soil filter medium) and other contaminants of concern. The need for these will follow more detailed design and water quality modelling where appropriate.

Alternatively, the total amount of runoff water estimated from the biomass area and plant area equates to 22ML/yr. Since around 23ML of water is required for plant processes and ash wetting, incorporation of a larger holding pond (around 32.5ML) is expected to be sufficient to contain this water for reuse resulting in no discharges during average climatic years. This can be achieved with a pond surface area of $6500m^2$ and depth of 5m.

6.1.3 Remainder of the Site

The remainder of the site contains neither plant or machinery, nor biomass storage areas. While there will be some road areas, this will not differ from the existing use and therefore the runoff quality will not differ from that existing. In total, due to containment of biomass runoff and treatment of plant runoff, the storm water leaving the site is expected to improve compared to the existing, largely uncontrolled state of the site.

6.2 Water Quality of Discharge Waters

Water discharged from the site as overland flow is proposed to come from two sources:

- treated Plant area runoff (assuming some of the water is not re-used); and
- remaining areas of the site other than Biomass and Feed Stockpile areas.

6.2.1 Plant Area Runoff

Water quality exiting a properly designed and maintained sediment pond from the Plant area is expected to be able to comply with reasonable suspended solids and turbidity limits as generally set during construction. If further treatment is required, further polishing to remove finer sediment, nutrients and metals can be undertaken in bio-remediation devices such as swales or bio-retention basins. With this treatment train, it is expected that Plant runoff will be able to be treated to match background water quality. This assumes that the water is not reused in the plant.

6.2.2 Remaining Site Area Runoff

This area is not expected to differ from the existing land use and it is proposed to allow this water to discharge as it does presently, in an uncontrolled manner other than any works required to prevent erosion of land surfaces.

6.2.2 Retention Pond Locations

Figures C1 to C3 show some indicative areas that can contain the required pond sizes, chosen to avoid further clearing of vegetation (other than under the feeder belts into the plant). Some difficulties may exist with some of the locations which have not been addressed here. These are therefore preliminary only but do indicate that sufficient space is available without further clearing.

7 REFERENCES

Curran, K.J., Droppo, I.G., Irvine, K.N. (2002). *Hydrology of Stockpiled Industrial Coal Exposed to Rainfall*. Hydrological Processes, v16, pp2788 – 2790.

BRS after CSIRO (1991). The Digital Atlas of Australian Soils. Bureau of Rural Sciences after Commonwealth Scientific and Industrial Research Organisation. Accessed from http://www.brs.gov.au/data/datasets.

Brisbane City Council's Sediment Basin Design, Construction and Maintenance Guidelines (January 2001).

Attachment A – 1 in 10 Year Storm Runoff Calculations

Location and Intensity-Frequency-Duration Details

Manjimup WA
Latitude: 34°20'11.45"S
Longitude: 116° 6'31.69"E
IFD information from Bureau of Meteorology Website:
http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml

Biomass Yard area

Using A = 2ha
From Australian Rainfall and Runoff, rational method using Jarrah forest with lateritic soils (as per Digital Atlas of Australian Soils[3]) – 100% cleared.

10yr, 24hr rainfall pattern:
Average intensity = 3.18mm/hr

Therefore, using initial loss from Australian Rainfall and Runoff for south west Western Australia with:

Proportional Loss (2yr) = L2 = $780x10^{-0.0015CL}P^{-0.31}$ = 64%.
Proportional Loss (10yr) = 0.97 x L2 = 62% for generally large catchments
For these areas, take L10 = 25%

Therefore,

With no losses, runoff depth = 3.18mm/hr x 24hr = 76.3mm
Runoff volume = 76.3mm / 1000 x 20000m^2 = 1526m^3 = 1.5ML

With proportional losses as above, runoff volume
= 76.3mm / 1000 x (1.0 - 0.25) x 20000 = 1145m^3 = 1.1ML

Feeder pile area

A = 2600m^2
From above with no losses,
Runoff volume = 76.3mm / 1000 x 2600m^2 = 198m^3 = 0.2ML

With 25% proportional losses:
Runoff volume = 198m^3 x 0.75 = 0.1ML

[3] BRS after CSIRO (1991). The Digital Atlas of Australian Soils. Bureau of Rural Sciences after Commonwealth Scientific and Industrial Research Organisation. Accessed from http://www.brs.gov.au/data/datasets.

Remainder of Feeder Pile Area

A = 1.5ha
From above with no losses,
Runoff volume = 76.3mm / 1000 x 15000m^2 = 1145m^3 = 1.1ML

With 25% proportional losses:
Runoff volume = 1145m^3 x 0.75 = 0.9ML

Plant Area

A = 1.6ha
From above with no losses,
Runoff volume = 76.3mm / 1000 x 16000m^2 = 1220m^3 = 1.2ML

As this area is fully sealed, no infiltration loss is calculated.

Attachment B – Conceptual Water Balance Diagrams

Figure B1: Flow Diagram – Scenario 1 – Reuse of Biomass Area Runoff only

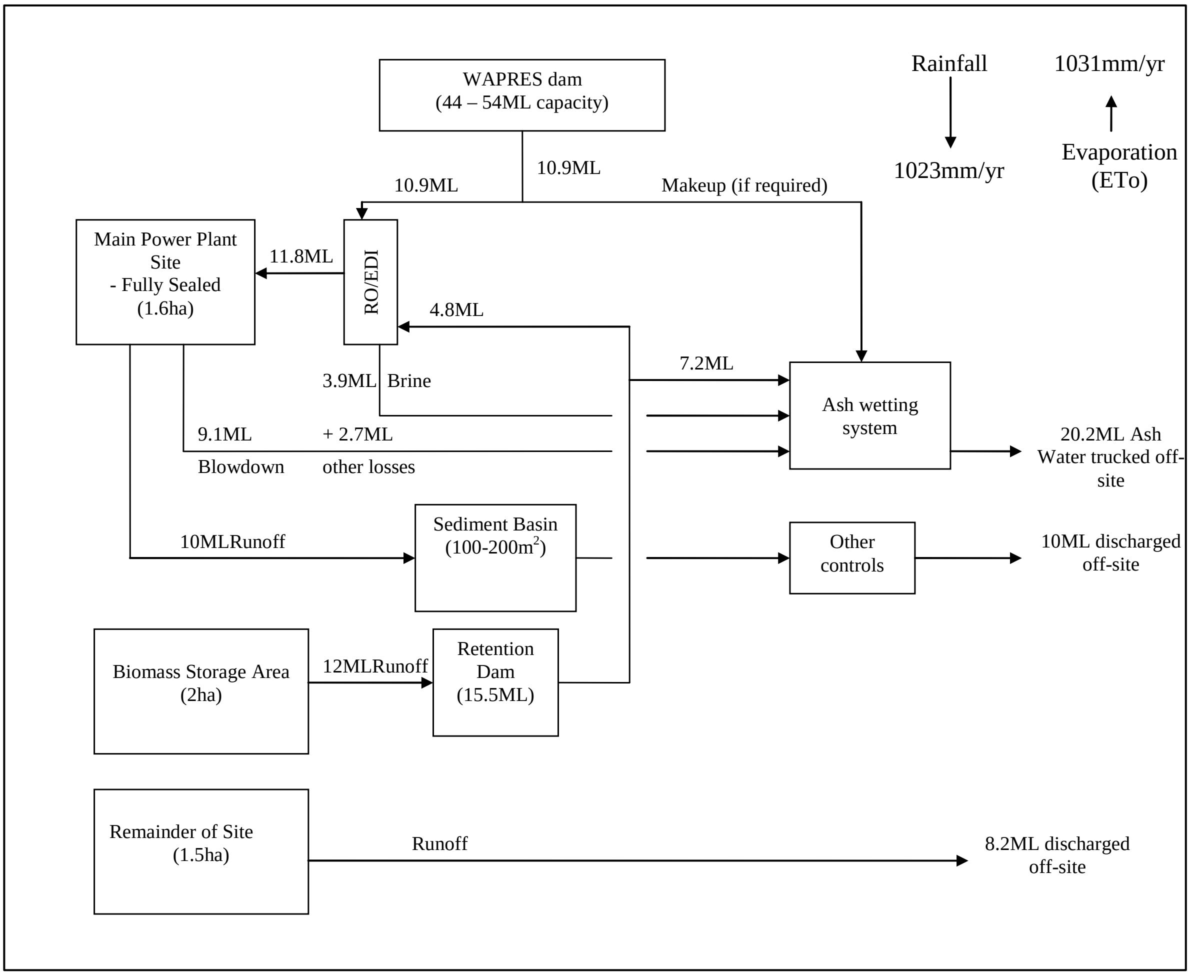
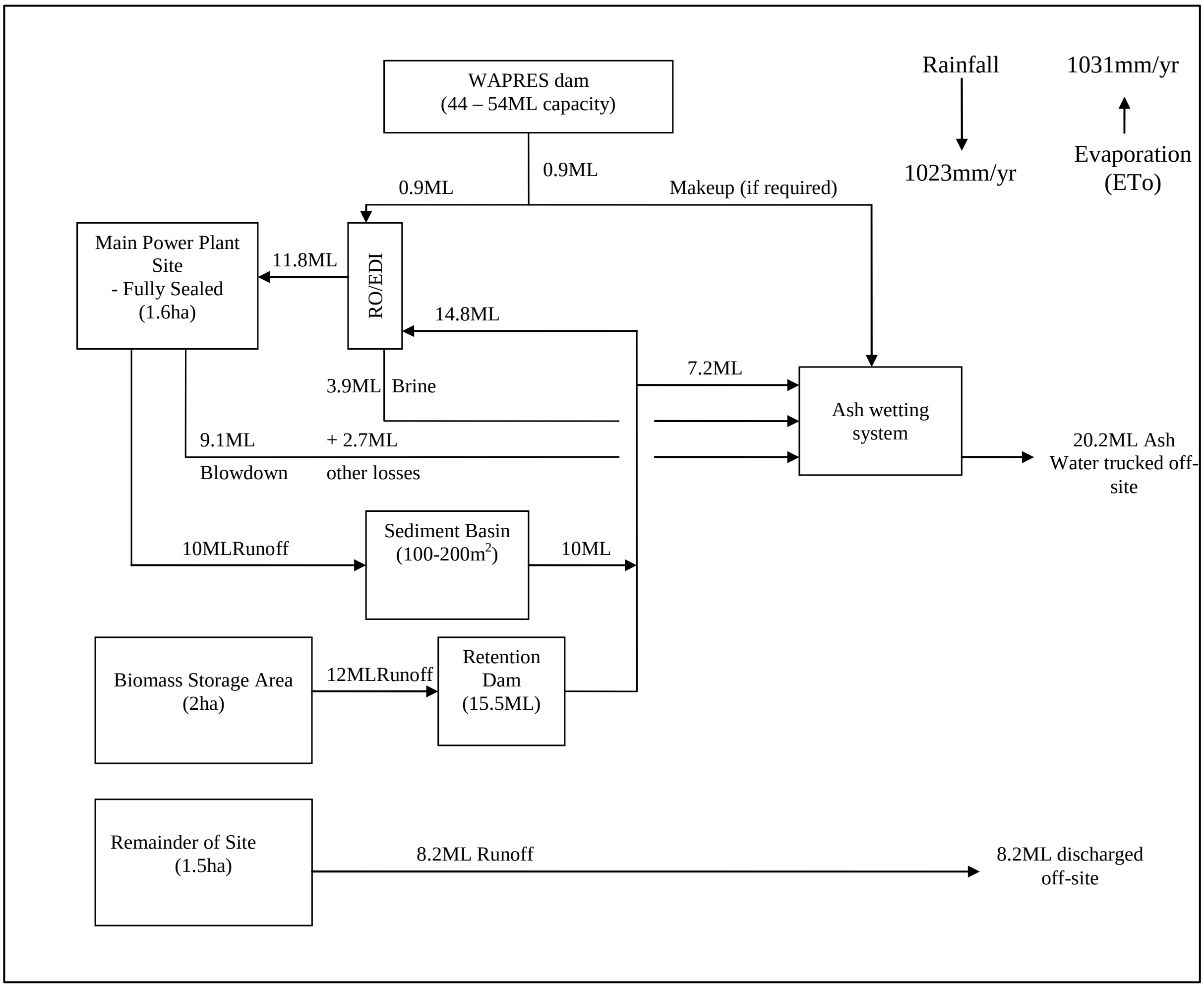
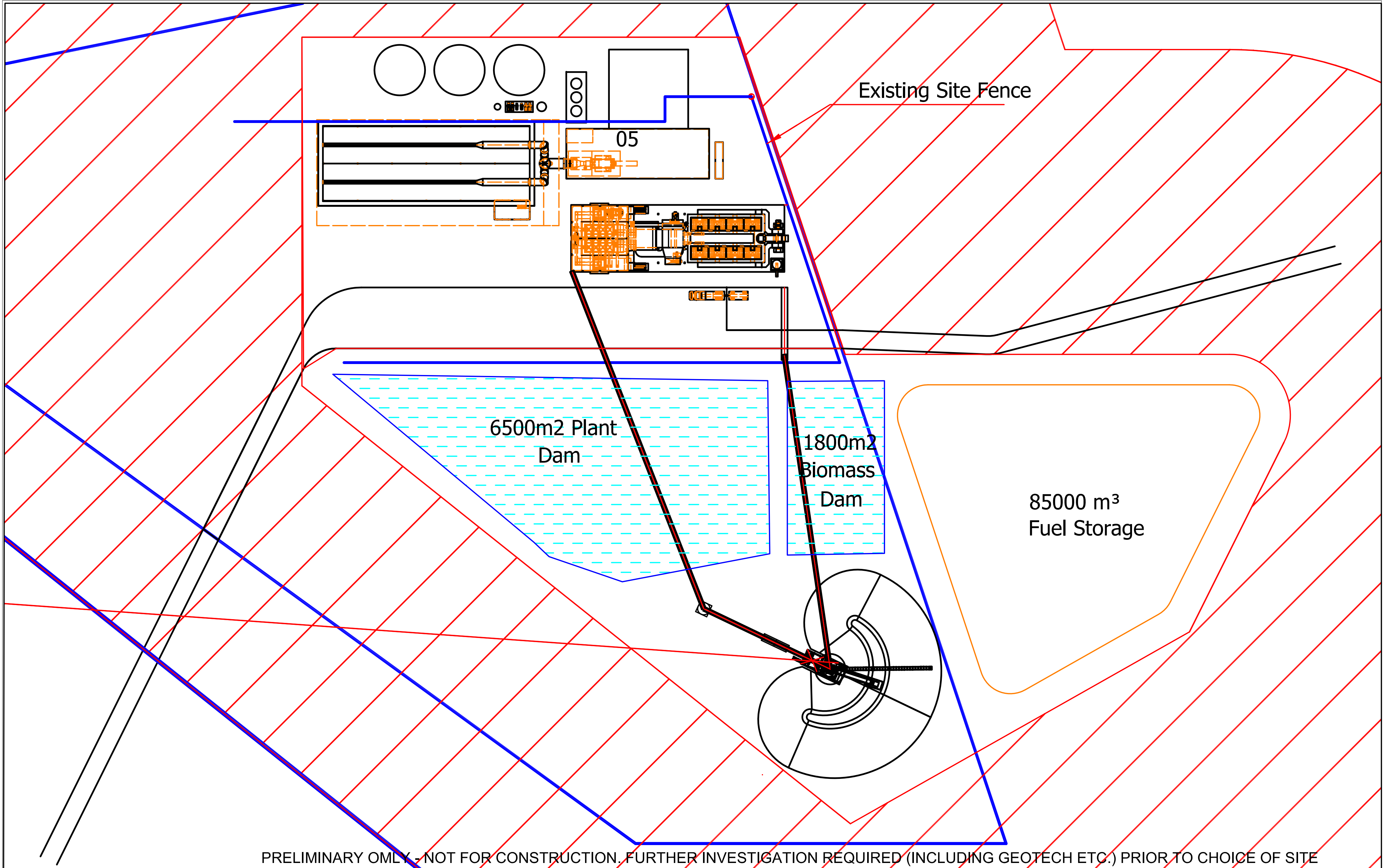


Figure B2: Flow Diagram – Scenario 2 – Reuse of Biomass area and Plant area runoff



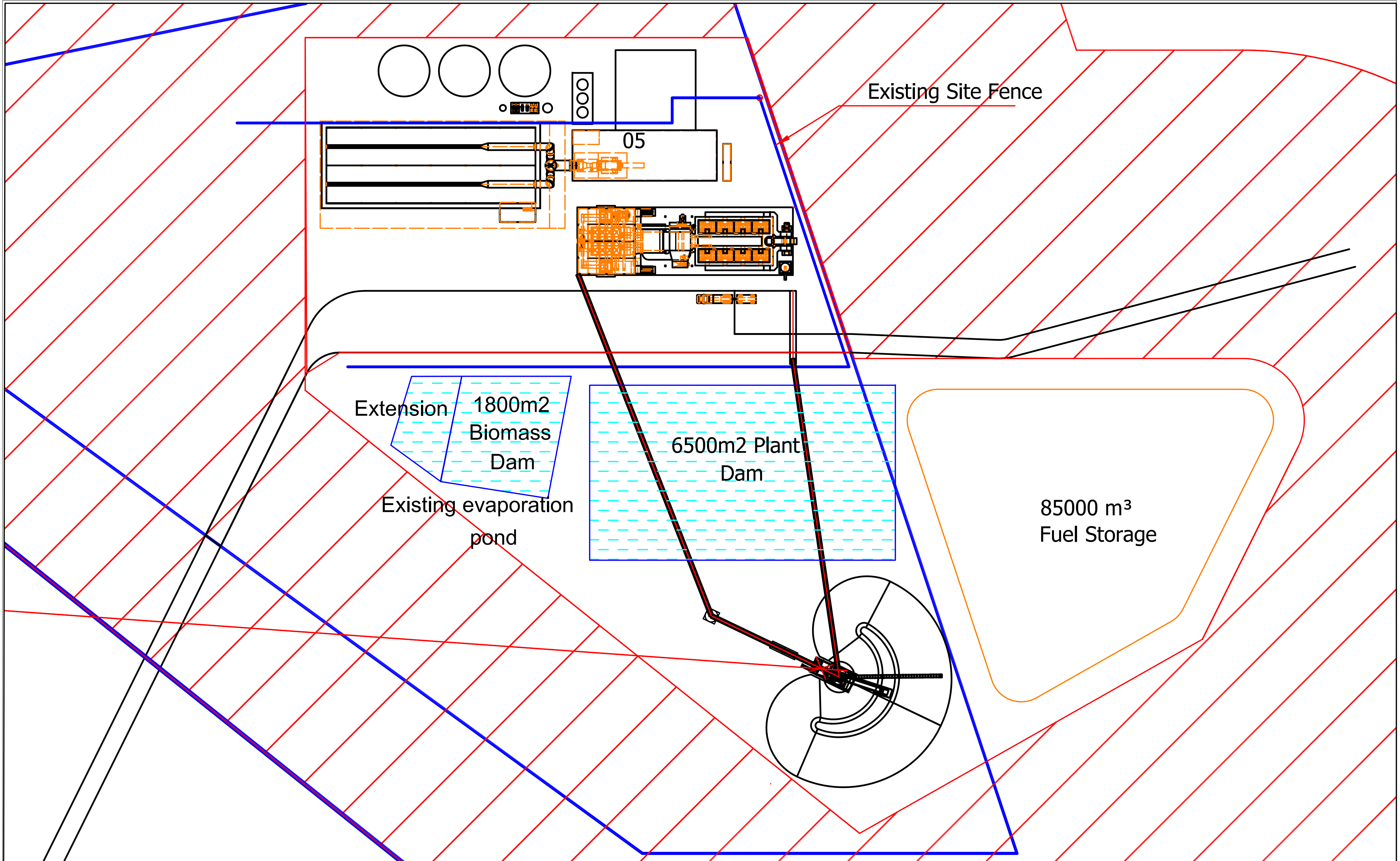
Attachment C – Potential Pond Locations



PRELIMINARY OMLY - NOT FOR CONSTRUCTION. FURTHER INVESTIGATION REQUIRED (INCLUDING GEOTECH ETC.) PRIOR TO CHOICE OF SITE

MBR Environmental
ABN 96 118 605 235
PO Box 5262, South Murwillumbah NSW 2484
t) 0427 145 932
f) 02 6672 7950
www.mbrenvironmental.com.au

LEVEL DATUM: NA	COORDINATE SYSTEM: N/A	CLIENT:	WESTERN AUSTRALIA BIOMASS PTY LTD	JOB NUMBER:	MBR08-008-1
SCALE: -	SHEET SIZE: A4	PROJECT:	PROPOSED BIOMASS POWER PLANT MANJIMUP WESTERN AUSTRALIA	DRAWING NUMBER:	C1
DRAWN: MW	DATE: APRIL 2008				
APPROVED: MW	DATE: APRIL 2008	TITLE:	SCHEMATIC OF PLANT SHOWING POTENTIAL AREAS FOR RETENTION PONDS - OPTION 1	REVISION	
ISSUE: FINAL					



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ABN 96 118 605 235
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t) 0427 145 932
f) 02 6672 7950
www.mbrenvironmental.com.au

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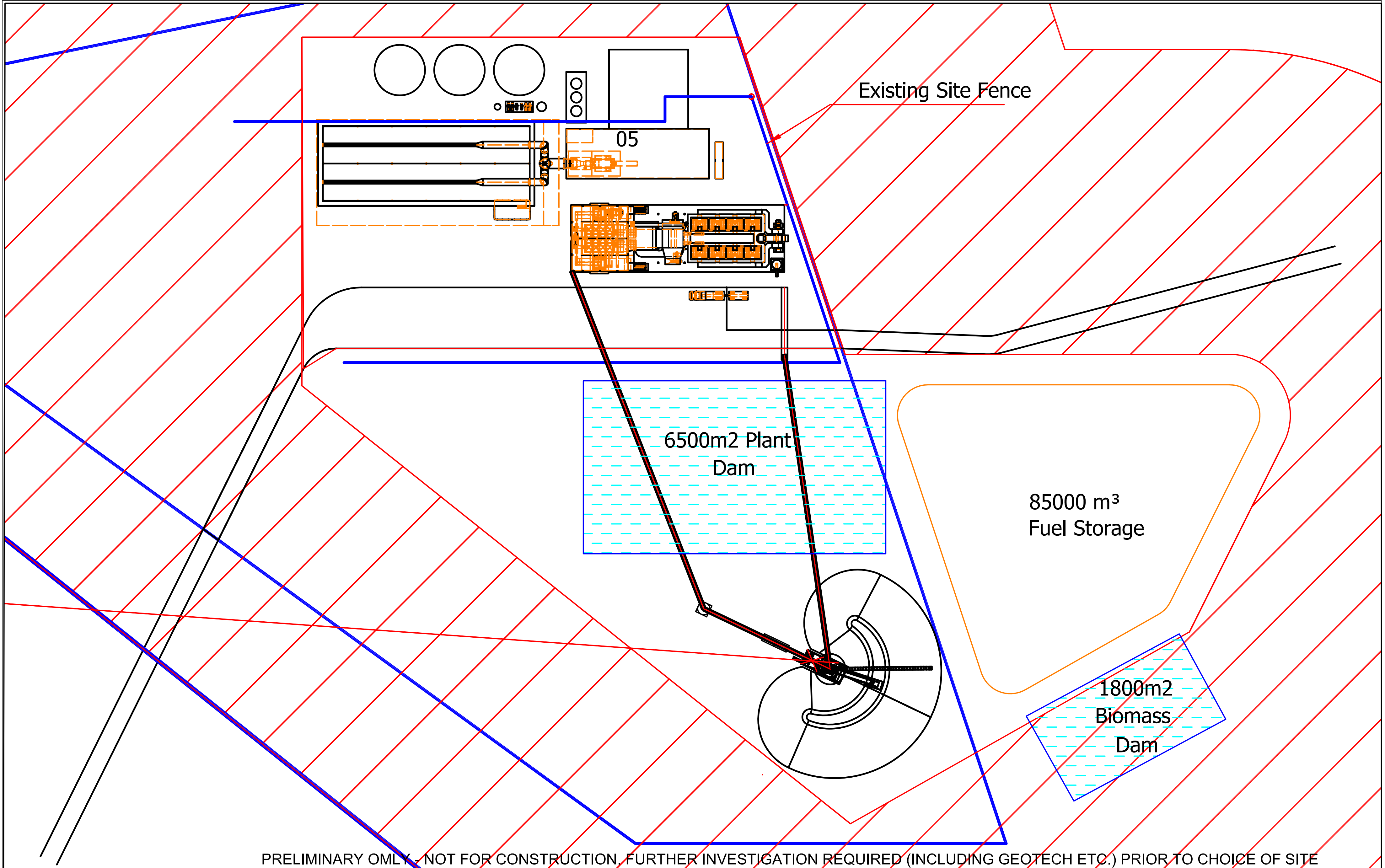
SCALE: -	SHEET SIZE: A4	PROJECT: PROPOSED BIOMASS POWER PLANT MANJIMUP WESTERN AUSTRALIA	DRAWING NUMBER: C2
DRAWN: MW	DATE: APRIL 2008		
APPROVED: MW	DATE: APRIL 2008	TITLE: SCHEMATIC OF PLANT SHOWING POTENTIAL AREAS FOR RETENTION PONDS - OPTION 2	REVISION
ISSUE: FINAL			



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MBR Environmental

ABN 96 118 605 235
PO Box 5262, South Murwillumbah NSW 2484
t) 0427 145 932
f) 02 6672 7950
www.mbrenvironmental.com.au

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SCALE: -	SHEET SIZE: A4	PROJECT: PROPOSED BIOMASS POWER PLANT MANJIMUP WESTERN AUSTRALIA	DRAWING NUMBER: C3
DRAWN: MW	DATE: APRIL 2008		
APPROVED: MW	DATE: APRIL 2008	TITLE: SCHEMATIC OF PLANT SHOWING POTENTIAL AREAS FOR RETENTION PONDS - OPTION 3	REVISION
ISSUE: FINAL			