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30th January 2011

Level 22,
101 Miller Street
North Sydney, NSW 2060

Attn: Ms Arianna Henty/Alex Kennedy-Clark

Dear Arianna/Alex,

RE: AGL Energy Limited Newcastle Gas Storage Facility – Storm Water Management Peer Review Part 1: Design Modelling

1 Background

Hunter Water Corporation has requested that SMEC Australia Pty Ltd undertake a peer review of the Storm Water Management Philosophy and Detailed Design of the Newcastle Gas Storage Facility (NGSF) situated in Tomago and Hexham in the NSW Hunter Region. WorleyParsons have conducted the previous modelling and design work on behalf of AGL Energy Limited (AGL) as a result of considerable consultation with a number of parties due to constraints on the disposal of stormwater on the site.

The NGSF site is underlain by the Tomago Sandbeds Aquifer, which is a source of raw water for the potable water supply for the Newcastle region. As a result, numerous changes to the original Stormwater Management Philosophy have been necessary to ensure that the possibility of contamination of this resource is kept to a minimum.

This document provides an overview of the current proposed Stormwater Management Strategy and reviews the methods and assumptions for the water quality and water quantity modelling previously conducted by WorleyParsons.

This document should be read in conjunction with the following documents:

- “Newcastle Gas Storage Facility Project – Surface Water Assessment” (WorleyParsons, 1 February 2011) (REF: 401010-00648-CI-SWMP_E)
- “Newcastle Gas Storage Facility – Revised Site Stormwater Management Philosophy” (WorleyParsons, 25 July 2011) (REF: 401020-03390-CI-REP-002_0)
- “Newcastle Gas Storage Facility – Stormwater Management Peer Review Part 1: Design Modelling” (WorleyParsons, 10 November 2011) (REF: 401020-03390-CW-CI-REP-004)

2 Overview of Current Philosophy

The stormwater management philosophy for the AGL site has undergone several significant changes since the original concept was developed. Initial strategies involved the use of bio-retention systems, constructed wetlands and infiltration ponds to process and discharge stormwater to the Tomago Sandbeds Aquifer. Concerns for the contamination of this potable water source have resulted in the current design philosophy displayed in **Attachment A.** **Attachment A** provides an overview of the current stormwater management philosophy, essentially removing the use of treated stormwater infiltration basins and instead relying on discharge to surface receiving waters. The current stormwater management principles are summarised as follows:

- No stormwater is to be infiltrated to the Tomago Sandbeds Aquifer with the exception of the LNG Tank & Bund Catchments, which are considered to be low pollutant risks as the LNG essentially evaporates when exposed to the atmosphere, leaving no pollutant residue.
- Plant areas are to be bunded in order to contain the 20 year ARI 24, hour storm event and storm water from this area is to be collected in an inspection tank and manually tested prior to release for further treatment. Where water quality is satisfactory it will be pumped into the stormwater treatment system and in the event of unsatisfactory water quality the stormwater will be pumped out, to a liquid waste system for appropriate treatment and disposal offsite.
- The site is to be graded such that the majority of the site drains to the south western corner. Runoff from the pervious areas flow directly into the wetland/holding pond configuration while the impervious areas are to be directed via a piped drainage system to a wet sump GPT and then to the wetland/holding pond.

Further detail on the site stormwater management principles can be found in the document "Newcastle Gas Storage Facility – Revised Site Stormwater Management Philosophy" (WorleyParsons, 25 July 2011) (REF: 401020-03390-CI-REP-002_0).

3 Review of Modelling

This section provides a review of the modelling work previously conducted and outlines the guidelines and assumptions that in SMEC's view should be applied to the water quality and water quantity modelling necessary for the AGL NGSF site.

3.1 Water Quality Modelling

3.1.1 Water Quality Objectives

For the water quality objectives the Port Stephens Council's treatment targets have been adopted. **Table 1** presents the water quality objectives as outlined in the document "Urban Stormwater and Rural Water Quality Management Plan" (Port Stephens Council, 2003).

Table 1 – Port Stephens Council's Water Quality Treatment Targets

Parameter	Target Pollutant Retention on Developed Site
Total Suspended Solids (TSS) (kg/yr)	80%
Total Phosphorus (TP) (kg/yr)	45%
Total Nitrogen (TN) (kg/yr)	45%
Gross Pollutants (GP) (kg/yr)	70%

SMEC consider that due to the change in stormwater discharge philosophy (i.e. change to discharge of stormwater offsite) the above treatment targets are appropriate.

3.1.2 Water Quality Model Review

Water quality modelling for the site has been undertaken with the urban stormwater improvement conceptualisation software MUSIC. In SMEC's view, modelling conducted in MUSIC should be done in accordance with the DRAFT New South Wales MUSIC Modelling Guidelines (BMT WBM, August, 2010). This document provides a guide to water quality modelling methodology and outlines the assumptions that should be made when selecting input parameters.

Figure 1 displays the current model, which has been conceptualised as 10 sub catchments according to their properties (such as impervious percentage, rainfall runoff parameters and pollutant load concentrations).

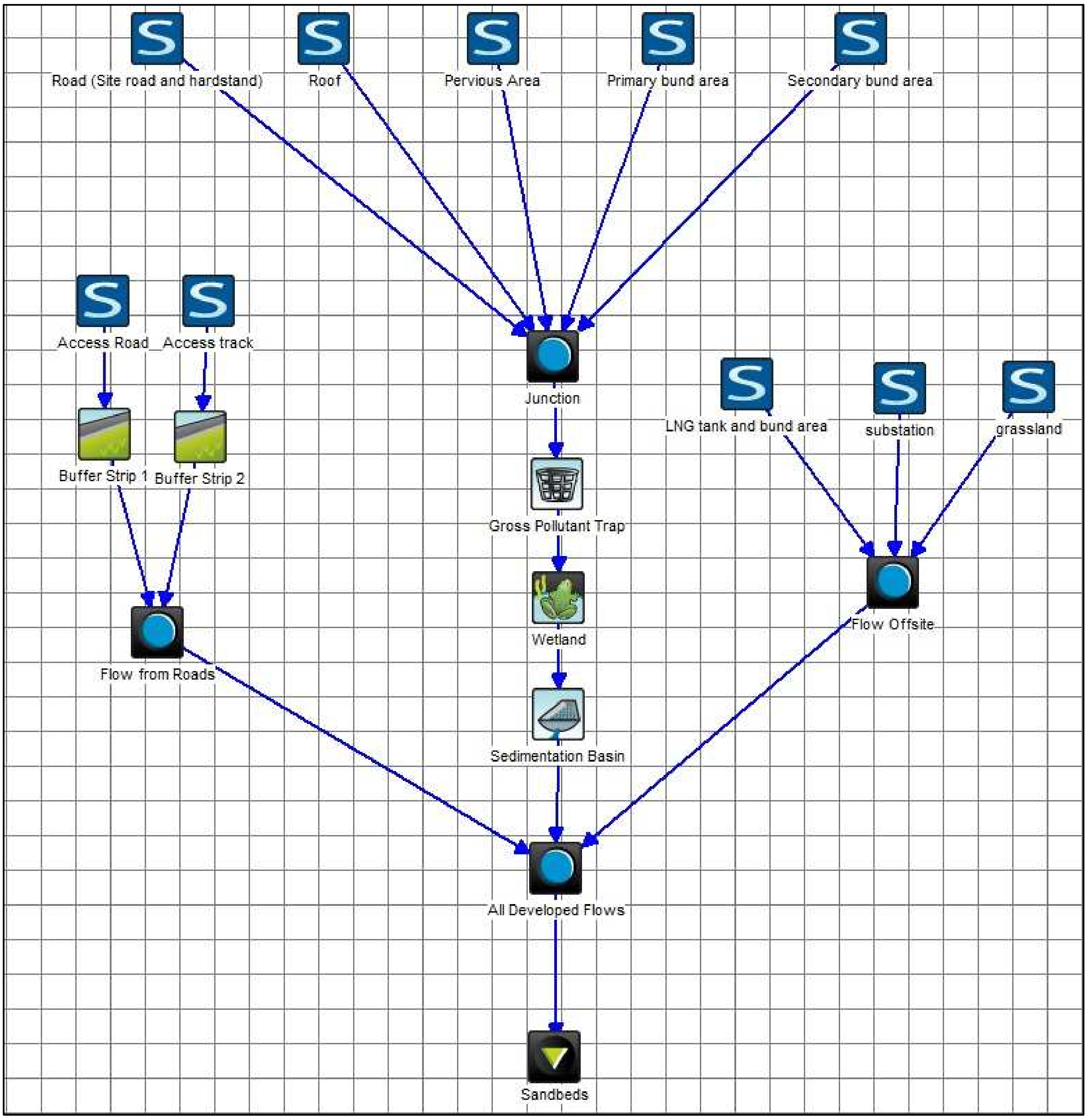


Figure 1 – MUSIC Schematic (WorleyParsons, 2010)

It may be noted in **Figure 1** that the receiving waters are labelled as “Sandbeds.” This node has no properties other than the purpose of outputting results. As such, this is simply a graphical error that has not been modified along with the design changes and does not affect the previous model results.

Basic data such as catchment areas and the ratios of impervious to pervious areas have been reviewed in the model and found to be consistent with the plans in **Attachment A.** The parameters for all nodes have been reviewed against the appropriate guidelines and notable differences are presented in **Table 1**. A detailed review of parameters and guidelines can be found in **Attachment B**.

Table 1 – Notable Water Quality Modelling Issues

Water Quality Modelling Issue	Current Procedures Adopted	Comments
Rainfall Data		
MUSIC requires a historical rainfall series, with a suggested 5 year minimum period (Draft NSW MUSIC Modelling Guidelines, BTM WBM August 2010) which closely reflects the mean annual rainfall for the modelled site.	The current music model has been revised to include 11 years of 6 minute pluiviograph rainfall data. Historical rainfall was taken from the Williamtown weather station as it is the nearest reliable gauge (10km) with a recent rainfall record. The historical rainfall records at Tomago weather station indicate that the site has a mean annual rainfall of approximately 1120mm. This was previously reflected in the 5 years of historical data, however the increase to 11 years has shown a reduction in mean annual rainfall of the sample to approximately 1020mm.	The decrease in the mean rainfall modelled for the site could cause a potential reduction in the total load of pollutants per year modelled for the receiving waters. This reduction is however within 9% of the mean annual rainfall for the Tomago historical data and can be considered negligible.
Runoff Yield Factor of Pervious Areas		
A check node was placed on the current MUSIC model to verify the level of runoff response the pervious areas of the catchment have in comparison with expected values outlined in the Constructed Wetlands Manual (Department of Land and Water Conservation, 1998). These guidelines suggest a runoff coefficient of 10–12.5% for shallow sand and loam soils where the mean annual rainfall lies between 900–1100mm.	The check node revealed a runoff coefficient of 28% for the pervious areas – more than double the expected runoff response outlined in the guidelines.	All parameters relating to the runoff response of pervious catchments were thoroughly checked and verified within the ranges suggested in the guidelines. The result of this check concludes the model is conservative in this respect as a higher runoff response would result in a higher total annual load of pollutants. SMEC suggest that the current runoff parameter be retained.
Initial Storage (% of Capacity)		
Guidelines suggest using the default parameter of 25% for initial storage.	Adopted parameter of 17% initial storage, slightly underestimating the total runoff.	As model is run over an 11 year period, to determine an average annual load of pollutants, an initial storage difference of this order can be considered negligible.

Table 1 summarises the main issues with the water quality modelling. All other differences in model assumptions (refer **Attachment B**) are either conservative or considered negligible.

Recommendations for the improvement of the water quality on site would include the diversion of stormwater flows from the substation to the treatment train. This would reduce the pollutants in the receiving waters further and be a safe design option in the event that future usage of this sub catchment provides higher pollutant storm water runoff. For example, recent pollution events in Lake Macquarie (in 2011) were attributed to a substation fire at the Vales Point power stations.

3.2 Water Quantity Modelling

Hydrologic modelling was undertaken using the software package DRAINS to analyse the water balance and assess storage capacities for the revised stormwater management plan. The DRAINS modelling has been reviewed and a water balance model has been additionally developed to verify the results found in the previous model.

3.2.1 Water Quantity Objectives

The main objectives of the management of water volumes on site are listed below:

- No overflows from the stormwater system are to occur in events up to the 72hr, 100yr ARI storm as these result in groundwater infiltration possibly leading to contamination.
- Bunded areas are sized to contain the 24hr, 20yr ARI storm
- The Holding Pond has no bypassing of flows up to the 72hr, 100yr ARI storm

3.2.2 Water Quantity Modelling Verification

Water balance modelling was undertaken by SMEC as a verification exercise using a scripted Visual Basic code with the following features:

- Input of Intensity Frequency Distribution (IFD) data for site specific design storm conditions
- Design Storms derived from "Australian Rainfall and Runoff" (IEAust, 1987)
- Modelled transfer between storages according to user set conditions
- Input of sub catchment areas with initial and continuing losses.

A range of design storms have been simulated using the water balance model for comparison to the Worley Parsons DRAINS model, in order to verify the sizing of the governing storage sizes required. A comparison of the assumptions made in the different modelling approaches is presented in **Table 2**.

Table 2 – Assumptions of the Two Modelling Methods

Assumption	WorleyParsons DRAINS Model	SMEC Water Balance Model
IFD Data	Parameters in the DRAINS model's IFD data are slightly different to that used in the water balance model resulting in slightly higher shorter duration rainfall and slight lower longer duration rainfall.	The IFD data in the water balance model was derived from co-ordinates central to the NGSF site. It is possible that co-ordinates in the DRAINS model were assumed for Williamtown to be consistent with the MUSIC modelling.
Runoff Lag Times	All flow paths are modelled with travel times and times of concentration are included in the catchment areas.	Water balance model does not account for any lag times, causing minimum storage sizes to be conservative.
Bunded Areas	Both models assume that the bunded areas detain stormwater until the wetland/holding pond configuration has sufficient storage available. Continuous transfer is not accounted unless overflows occur. If this is policy is not adequate for the detailed design and final stormwater management philosophy, both models will under predict the storage required in downstream reservoirs.	
Roof Tank Water Reuse	Initial concept designs by WorleyParsons included the use of rainwater tanks for storage of roof runoff. Both models assume no rainwater tank storage and are conservative in this respect.	
Wetland/Holding Pond Configuration	Modelled as separate storages.	Modelled as a single storage for simplicity to assess the results of DRAINS model.
Runoff Losses	Depression storage of 1mm for Impervious and 5mm for Pervious areas are adopted. Continuing losses in the pervious areas are accounted for by the Horton equation using a decaying soil storage rate initially set to 40mm/hr.	Model uses initial (IL) and continuing losses (CL). To verify the DRAINS model these are set to 1mm (IL) and 0mm/hr (CL) for Impervious sub catchments and 5mm (IL) and 30mm/hr (CL) for pervious sub catchments. The pervious area CL parameter is taken as a lower value than used in the DRAINS model as it is fixed and does not have a decaying rate with time. These parameters are considered conservative for the on-site conditions.
Pump Offsite Condition	The pump offsite is set to turn on when storage in the pond reaches a volume of 1095m^3.	The same volumetric condition of 1095m^3 is assumed in the water balance as a percentage of the combined reservoir storage.

Notable in **Table 2** is the difference in the assumptions made for design storm input data. The effect of this was assessed by running the water balance model with the same input data used in the DRAINS model and was found to cause a negligible difference in results.

Table 3 states the input data used for the water balance modelling as derived from the previous WorleyParsons reports and assumed for consistency with the DRAINS model.

Table 3 – Water Balance Input Data

Sub Catchment	Linked to Storage	Area (ha)	Initial Loss (mm)	Continuing Loss (mm/hr)
Pervious Areas (Grassland)	Wetland/Holding Pond	4.42	5	30
Roofs	Wetland/Holding Pond	0.16	1	0
Roads	Wetland/Holding Pond	1.13	1	0
Primary Bund	Bunded Area	0.29	1	0
Secondary Bund	Bunded Area	0.4	1	0
Substation	Substation Bund	0.21	1	0

3.2.3 Water Balance Results

The minimum storage required for bunded areas and the wetland/holding pond configuration is tabulated in **Attachment C**. **Figure 2** summarises the storage required in the wetland/holding pond configuration for the 100 year ARI event.

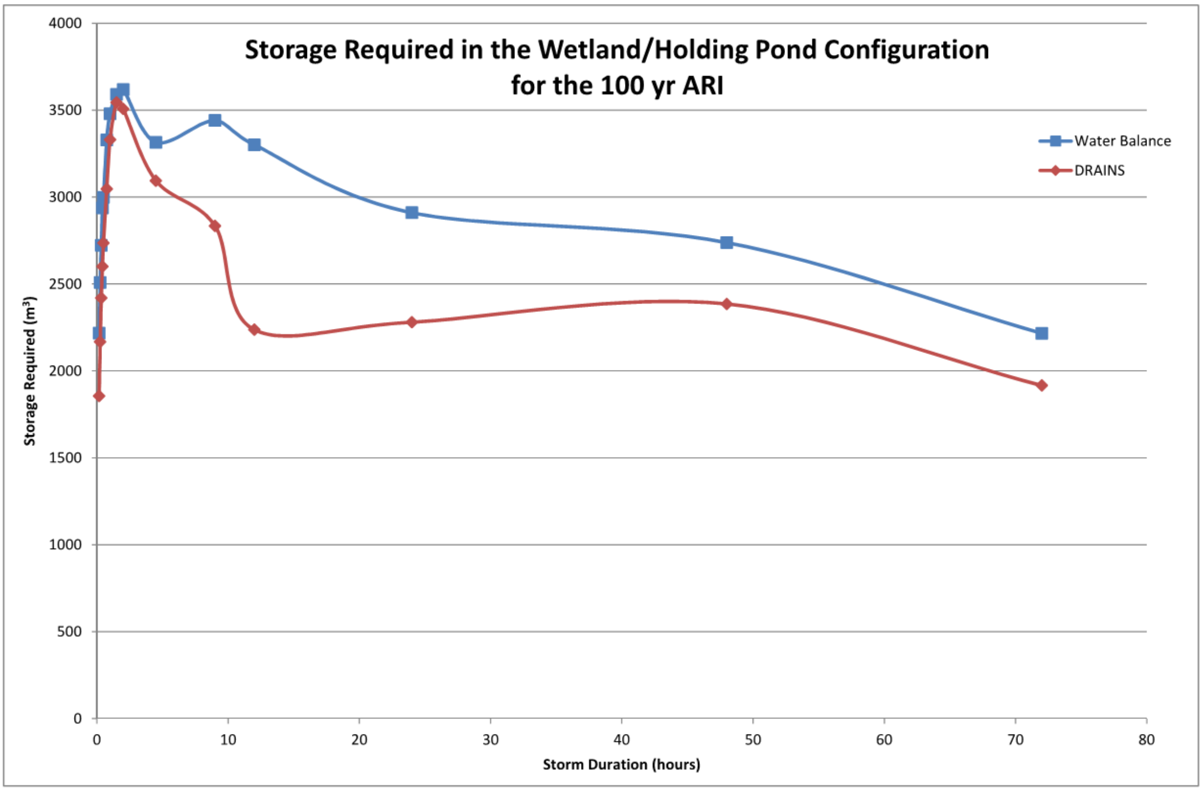


Figure 2 –Comparison of DRAINS and Water Balance Modelling Results

Figure 2 compares the results of the Water Balance and the DRAINS model for the 100 year ARI for a range of storm durations. The peak storage calculated in the model is 3544m^3, which contains the 1.5 hour duration storm. Comparatively, the peak storage calculated in the Water Balance model is 3619m^3, which contains the 2 hour storm duration.

Figure 2 displays a reduction in storage required with the increase of storm durations. This is due to the pump outflow of the storage system, which can withdraw larger volumes over a longer duration. The Water Balance results show a slower decay in storage required, as continuing losses in the model are fixed and are conservative. The DRAINS model assumes a non-linear rate of groundwater infiltration as it accounts for the rate of soil moisture uptake as a function of the soil moisture storage.

The difference in peak storage results between the models are considered negligible as they are in the order of 2-3%, verifying that the DRAINS modelling is sufficient for assessing the storage required for the storm water management plan.

A more conservative approach, such as the water balance model, may be beneficial as it may be noted in **Figure 2** the change in volume of the longer duration storms is significant between the two models. The models assume that pumping occurs at the full capacity of design. If this is not the case and some pump efficiency is lost, the maximum storage required could easily be governed by a longer duration storm such as the 12hr event in the water balance model. It is recommended that WorleyParsons adopt a conservative approach similar to SMEC and simulate some lower pump efficiency scenarios to account for this.

3.3 Limitations of Modelled Results

It is understood that the detailed design of the plant is subject to change. As such, significant changes to the catchment area boundaries, sizes and types have the potential to change the model results and subsequent remodelling will be necessary.

4 Conclusions and Recommendations

The modelling previously completed by WorleyParsons has been reviewed and verified and is considered consistent with the modelling approaches taken by SMEC. All differences in assumptions are outlined in the above report, however most are considered negligible to the validity of the previous models.

The previous water quality modelling was found to have a generally consistent approach to that outlined in the DRAFT NSW MUSIC Modelling Guidelines. Some small discrepancies have been documented however are considered negligible as the larger number of conservative assumptions taken would discount these issues.

The water quantity verification undertaken with a water balance approach concludes that the DRAINS model is relatively consistent with the expected level of storages required in the stormwater system to detain runoff and prevent groundwater infiltration; however it is suggested that the model be re-run using the correct IFD data, and some conservatism be introduced to account for possible pump inefficiencies which could result in unplanned overflow of the storages.

It is recommended to divert the stormwater flow of the substation catchment to improve water quality of the receiving waters. Although this is not considered necessary by the WorleyParsons reports, it could prove to be a safer design option in the event that future use of the substation provides higher pollutant runoff.

Should you have any questions or wish to discuss this assessment further, please don't hesitate to contact Ben Patterson on 4925 9626 or mobile 0408 005 660.

Yours sincerely,

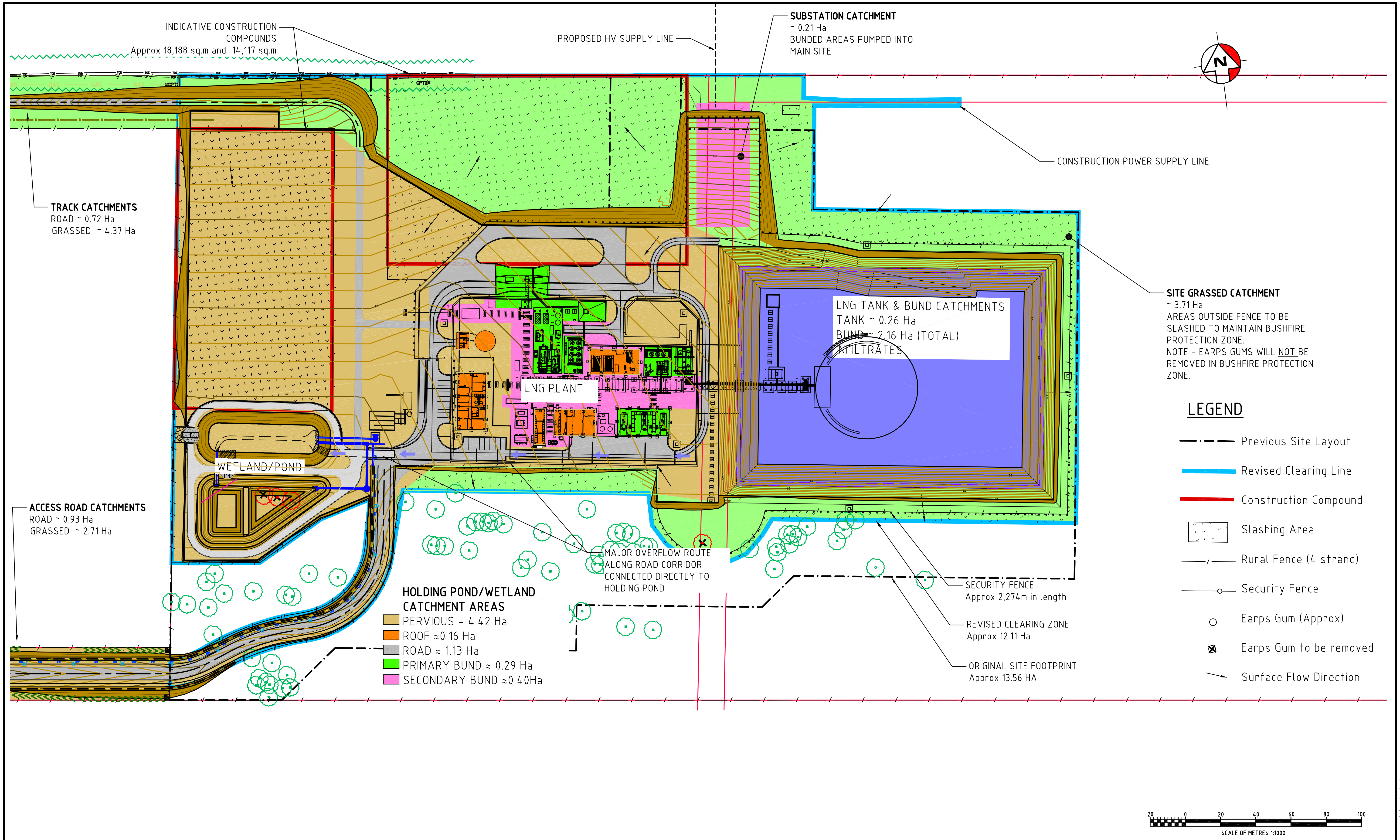
Ben Patterson
Manager, Water Resources and Environmental, NSW/ACT

Attachments

Attachment A – Current Stormwater Catchment Plan (WorleyParsons, October, 2011)

Attachment B – Detailed MUSIC Modelling Parameters and Guidelines

Attachment C – Comparison of Water Balance and DRAINS Results



REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
B	10.10.11	UPDATED MODELLING FOLLOWING DESIGN	BO			BO			401020-03390-CI-DSK-0006_C	UPDATED SITE LAYOUT (APPROVED BY AGL)
A	18.09.2011	PRELIMINARY LAYOUT FOR MODELLING	BO	CD	BO	GS	SH		10256C	SURVEY BY MONTEATH AND POWYS

A1 SHEET SCALE

OneWay™ to zero harm

WORLEYPARSONS PROJECT No. 401020-03390

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER AGL

WorleyParsons resources & energy

NEWCASTLE GAS STORAGE FACILITY UPDATED STORMWATER CATCHMENT PLAN ISBL SITE DETAILS

DRG No 401020-03390-CI-DSK-0008A REV B

WORLEYPARSONS_A1_REV2

LOCATION: O:\401020\03390 - AGL OSBL NEWCASTLE GSF\11.0 ENGINEERING\11.01 CIVIL INFRASTRUCTURE\04 STORMWATER MODELLING - DETAILED DESIGN\04 CATCHMENT PLAN\401020-03390-CI-DSK-0008_B.DWG

USER NAME: brian.oberdorf

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Attachment B – MUSIC Parameters Adopted

Table B1 – Hydrology Parameters.

Input Data	Value Adopted	Guidelines Value	Comments
Pervious Area Properties			
Soil Storage Capacity (mm)	175	175	Sandy Soil Root Zone 0.5m *(OK)* **(Table 3-7)**
Initial Storage (% of Capacity)	17	25	Default Parameter should be adopted **(Section 3.6.4.3)** -Slight underestimate in runoff would occur from this assumption; however model is run of 11 years so considered negligible.
Field Capacity (mm)	74	74	Sandy Soil Root Zone 0.5m *(OK)* **(Table 3-7)**
Infiltration Capacity Coefficient – a	360	360	Sand, Loamy Sand *(OK)* **(Table 3-8)**
Infiltration Capacity Coefficient – b	0.50	0.50	Sand, Loamy Sand *(OK)* **(Table 3-8)**
Groundwater Properties			
Initial Depth (mm)	10	10	Default Parameter should be adopted *(OK)* **(Section 3.6.4.3)**
Daily Recharge Rate (%)	100	100	Sand, Loamy Sand *(OK)* **(Table 3-8)**
Daily Baseflow Rate (%)	50	50	Sand, Loamy Sand *(OK)* **(Table 3-8)**
Daily Deep Seepage Rate (%)	0	0	Sand, Loamy Sand *(OK)* **(Table 3-8)**

Input Data	Value Adopted	Guidelines Value	Comments
Impervious Area Properties (Rainfall Threshold (mm/day))			
Site Road and Hardstand	1.5	1.5	Unsealed Roads (*OK*) **(Table 3-6)**
Roof	0.3	0.3	Roofs (*OK*) **(Table 3-6)**
Primary Bund Area	1.0	1.5	Should adopt 1.5mm for sealed areas however conservative so *OK* **(Table 3-6)**
Secondary Bund Area	1.0	1.5	Should adopt 1.5mm for sealed areas however conservative so *OK* **(Table 3-6)**
Access Road	1.5	1.5	Sealed Road (*OK*) **(Table 3-6)**
Access Track	1.5	1.5	Unsealed Road (*OK*) **(Table 3-6)**
LNG Tank and Bund Area	1.0	1.5	Should adopt 1.5mm for sealed areas however conservative so *OK* **(Table 3-6)**
Substation	1.5	1.5	Sealed Area (*OK*) **(Table 3-6)**

Table B2 – MUSIC Stormwater Pollutant Input Parameters Adopted

Input Data	Value Adopted	Guidelines Value	Comments
Site Road and Hardstand (Storm Flow Concentration Parameters)			
TSS (mean (log mg/L))	2.430	2.43	Sealed Roads (*OK*) **(Table 3-10)**
TP (mean (log mg/L))	-0.300	-0.30	Sealed Roads (*OK*) **(Table 3-10)**
TN (mean (log mg/L))	0.340	0.34	Sealed Roads (*OK*) **(Table 3-10)**
Roof (Storm Flow Concentration Parameters)			
TSS (mean (log mg/L))	1.300	1.30	Roofs (*OK*) **(Table 3-10)**
TP (mean (log mg/L))	-0.890	-0.89	Roofs (*OK*) **(Table 3-10)**
TN (mean (log mg/L))	0.300	0.30	Roofs (*OK*) **(Table 3-10)**
Pervious Area (Base Flow Concentration Parameters)			
TSS (mean (log mg/L))	1.176	1.15	Assume as Rural Residential as open grassland (**Table 3-9)** Conservative value for TSS so *OK*
TP (mean (log mg/L))	-1.222	-1.22	Assume as Rural Residential as open grassland (**Table 3-9)** (*OK*)
TN (mean (log mg/L))	-0.027	-0.05	Assume as Rural Residential as open grassland (**Table 3-9)** Conservative value for TN so *OK*

Input Data	Value Adopted		Guidelines Value		Comments
Primary and Secondary Bund Areas and Substation Catchment (Storm Flow Concentration Parameters)					
TSS (mean (log mg/L))	2.150		2.15		Industrial (*OK*) **(Table 3-10)**
TP (mean (log mg/L))	-0.600		-0.60		Industrial (*OK*) **(Table 3-10)**
TN (mean (log mg/L))	0.300		0.30		Industrial (*OK*) **(Table 3-10)**
Grassland (Base Flow Concentration Parameters)					
TSS (mean (log mg/L))	1.150		1.15		Rural Residential (*OK*) **(Table 3-9)**
TP (mean (log mg/L))	-1.220		-1.22		Rural Residential (*OK*) **(Table 3-9)**
TN (mean (log mg/L))	-0.050		-0.05		Rural Residential (*OK*) **(Table 3-9)**
LNG Tank and Bund (Base Flow and Storm Flow Concentration Parameters)					
	Pervious	Impervious	Pervious	Impervious	
TSS (mean (log mg/L))	1.200	2.150	1.200	2.150	Industrial (*OK*) **(Table 3-9, 3-10)**
TP (mean (log mg/L))	-0.850	-0.600	-0.850	-0.600	Industrial (*OK*) **(Table 3-9, 3-10)**
TN (mean (log mg/L))	0.110	0.300	0.110	0.300	Industrial (*OK*) **(Table 3-9, 3-10)**

Input Data	Value Adopted		Guidelines Value		Comments
	Pervious	Impervious	Pervious	Impervious	
Access Road (Base Flow and Storm Flow Concentration Parameters)					
TSS (mean (log mg/L))	1.200	2.430	1.200	2.430	Sealed Roads (*OK*) **(Table 3-9, 3-10)**
TP (mean (log mg/L))	-0.850	-0.300	-0.850	-0.300	Sealed Roads (*OK*) **(Table 3-9, 3-10)**
TN (mean (log mg/L))	0.110	0.340	0.110	0.340	Sealed Roads (*OK*) **(Table 3-9, 3-10)**
Access Road (Base Flow and Storm Flow Concentration Parameters)					
TSS (mean (log mg/L))	1.200	3.000	1.200	3.000	Unsealed Roads (*OK*) **(Table 3-9, 3-10)**
TP (mean (log mg/L))	-0.850	-0.300	-0.850	-0.300	Unsealed Roads (*OK*) **(Table 3-9, 3-10)**
TN (mean (log mg/L))	0.110	0.340	0.110	0.340	Unsealed Roads (*OK*) **(Table 3-9, 3-10)**

Table B3 – Treatment Node Parameters.

Input Data	Value Adopted	Guidelines Value	Comments
Buffer Strips			
Exfiltration Rate (mm/hr)	360.00	0.1 or 0.15	Guidelines suggest using a max of either 0.1 or the average PET rate = 0.15mm/hr. **(Section 3.8.1.2)**, however MUSIC suggests 360mm for sand areas. The Sites pervious areas would be subject to a greater infiltration than the guidelines parameters would provide and it is assumed that this maximum value is intended for pervious areas only (*OK*)
Gross Pollutant Trap			
Low Flow Bypass (m^3/s)	0	0	(*OK*) **(Table 3-13)**
High Flow Bypass (m^3/s)	0.110	50% of Peak 1 yr ARI Flow = 0.130	*OK* as adopted value is conservative **(Table 3-13)**
TSS, TP, TN	Values adopted from **T3-13**	**Table 3-13**	Adopted Values Consistent with **Table 3-13**, *OK*.
Gross Pollutants	Values larger than T3-13	**Table 3-13**	Values different to **Table 3-13** however adopted values are conservative so *OK*
Wetland			
High Flow Bypass (m^3/s)	0.110	50% of Peak 1 yr ARI Flow = 0.130	*OK* as adopted value is conservative **(Section 3.8.3.1)**
All other Parameters	Default		*OK*

Input Data	Value Adopted	Guidelines Value	Comments
Sedimentation Basin			
Node Choice	Sedimentation Basin	-	Node would have Ideally been modelled as a pond to reflect site conditions. Sedimentation basin assumes previously deposited sediments from further up the treatment train. Parameter C* for TSS was however adjusted to reflect actual site conditions so OK

Attachment C - Comparison of Water Balance and DRAINS Results

	Substation Catchment				Plant Bunds			
	10 yr ARI		100 yr ARI		10 yr ARI		100 yr ARI	
Duration	WB	DRAINS	WB	DRAINS	WB	DRAINS	WB	DRAINS
10min	39	-	60	90	128	-	196	201
15min	50	51	75	77	163	167	247	254
20min	58	60	88	61	190	196	288	267
25min	66	67	100	101	218	220	330	332
30min	71	74	107	110	233	242	353	362
45min	86	89	129	133	282	293	425	438
1hr	97	101	147	151	320	331	483	497
1.5hr	115	-	174	177	377	-	571	583
2hr	129	130	195	196	423	428	640	643
3hr	151	-	228	-	495	-	750	-
4.5hr	176	-	267	259	578	-	878	850
6hr	196	-	299	-	646	-	982	-
9hr	230	221	350	329	754	726	1150	1080
12hr	256	245	392	363	843	805	1287	1194
18hr	307	-	472	-	1009	-	1551	-
24hr	349	336	538	-	1146	1103	1767	-
30hr	383	-	593	-	1260	-	1949	-
36hr	413	-	641	-	1357	-	2107	-
48hr	463	389	722	-	1520	1286	2371	-
72hr	533	-	837	-	1752	-	2750	-

	Wetland		Holding Pond		Combined Wetland/Holding Pond Configuration			
	10 yr ARI	100 yr ARI	10 yr ARI	100 yr ARI	10 yr ARI		100 yr ARI	
Duration	DRAINS	DRAINS	DRAINS	DRAINS	DRAINS	WB	DRAINS	WB
10min	-	220	-	1636	-	665	1856	1217
15min	182	266	400	1901	582	838	2167	1509
20min	219	320	497	2100	716	1055	2420	1723
25min	255	364	580	2237	835	1129	2601	1938
30min	286	394	656	2342	942	1155	2736	1998
45min	333	478	846	2569	1179	1243	3047	2328
1hr	367	556	976	2774	1343	1401	3330	2479
1.5hr	-	649	-	2895	-	1416	3544	2590
2hr	450	710	1105	2797	1555	1395	3507	2619
3hr	-	-	-	-	-	1216	-	2487
4.5hr	-	808	-	2286	-	1202	3094	2315
6hr	-	-	-	-	-	1112	-	2092
9hr	657	813	1106	2021	1763	1206	2834	2441
12hr	673	812	1104	1425	1777	1214	2237	2300
18hr	-	-	-	-	-	1096	-	1561
24hr	694	805	1104	1475	1798	1104	2280	1910
30hr	-	-	-	-	-	1109	-	1521
36hr	-	-	-	-	-	1100	-	1665
48hr	775	810	1105	1575	1880	1130	2385	1738
72hr	-	800	-	1116	-	1099	1916	1216