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Project 72744.04
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GSY:dh

Attention: Mr Robert Brown

Email: Robert.Brown.Botany@kbr.com

Dear Sirs

Earthworks Report for Southlands Industrial Park, Stage 2 Southlands Industrial Park, Banksmeadow

1. Introduction

This report presents a summary of geotechnical inspections and earthworks testing operations associated with the bulk filling works undertaken for the Southlands Industrial Park Stage 2, McPherson Street, Banksmeadow.

The scope of testing and inspections provided by Douglas Partners Pty Ltd (DP) included stripping inspections and density testing in general accordance with a Level 1 standard, as defined in AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

2. Bulk Filling

2.1 Extent of Works

The Southlands Industrial Park site occupies an area some 500 m by 300 m which is to be developed in stages. Stage 2 is located on the eastern half of the site and is separated from the eastern half by Springvale Drain. Stage 2 is to be prepared for occupation by industrial buildings.

For earthworks purposes, the earthworks contractor, Enviropacific, divided the site into four areas, which were nominally called Lots 1 to 4 and the works were generally carried out on in stages. Earthworks was generally restricted to Lots 1, 2 and 3 with little earthworks carried out on Lot 4, which was the biggest lot. See attached plan for site drawing.

Before earthworks began, the site was covered in thick vegetation.

Earthworks involved stripping the site of vegetation, topsoil and unsuitable material, excavating any 'high' areas to final subgrade level, high energy impact compaction of the exposed surface and filling the site to final subgrade level for the low lying areas.

2.2 High Energy Impact Compaction

As the area was stripped of the vegetation and topsoil, excavation was carried out to bring the higher existing surface to design subgrade level. A geotechnician or geotechnical engineer inspected the stripped areas and approved the area for further works. The stripped surfaces generally exposed sandy material. The area was then subjected to high energy impact compaction (HEIC) until the average settlement over the lot was less than 10 mm per 5 passes of HEIC roller.

2.3 Proof Rolling

Following HEIC, the surface was compacted using a conventional roller. A geotechnician or geotechnical engineer inspected the prepared areas and any soft spots were repaired.

2.4 Filling Materials

Filling materials were won from the cut areas, fill mounds and stockpiles located on the Orica site. They generally comprised brown gravelly sand.

2.5 Specifications

The specification required filling to be compacted relative to Standard compaction. The minimum density ratios were agreed before works commenced and varied according to the situation. They were:

Bulk Filling:	98% density ratio
Existing Subgrade:	100% density ratio

The moisture specification adopted for this project was a range of 2% dry to 2% wet of Standard optimum moisture content.

The frequency of testing aimed to achieve a minimum rate of 1 test per 200 m³ or one test per layer per 1000 m² of filling, whichever required the most tests.

2.6 Placement and Testing of Filling

Observation of the compaction and density testing of the works were carried out by a geotechnician, who was on-site full-time during placement of filling.

Filling was placed by excavator and trucks and compacted using a 20 tonne smooth drum roller and an 825 compactor. Dozers were also used to spread filling materials. A smaller 7 tonne roller was used on sensitive areas such as over buried propane pipes.

The filling was placed progressively in lots between 20 March 2015 and 12 May 2015 in layer thicknesses of approximately 300 mm or less in a continuous operation across the filling area within each lot. Filling depths were generally monitored by reference to on-site survey marks and reduced levels supplied by the earthworks contractor. Testing occurred at random locations selected by DP's geotechnician on each layer of filling. During placement of filling the contractor was advised of the test results both in terms of density and moisture content.

Field density testing was undertaken using a nuclear densometer gauge, in accordance with AS1289 5.8.1-2007. Compaction testing was completed using the Hilf compaction method in accordance with AS1289 5.7.1-2006. Levels were provided by the contractor for all test locations and were recorded by DP.

A total of 86 density tests were carried out between 20 March 2015 and 12 May 2015. The test locations were chosen by DP's geotechnician and generally covered the filling area. A test result summary is attached to this report.

Tables 1 to 2 below provide further details of the test results.

Table 1: Bulk Filling – Density Test Results	Compaction	Moisture
Specification	98% Standard	- 2.0% to 2.0%
No. of Tests	53	53
No. of Test Outside Specification	0	0
Range of Test Results	98.0% to 101.5%	- 2.0% to 0.5%
Average	99.3%	1.5% dry

Table 2: Subgrade Layer – Density Test Results	Compaction	Moisture
Specification	100% Standard	- 2.0% to 2.0%
No. of Tests	32	32
No. of Test Outside Specification	0	0
Range of Test Results*	100.0% to 105.5%	- 2.0% to 0.5%
Average	100.9%	1.3% dry

All tests passed the specification requirements.

3. Comments

Douglas Partners Pty Ltd undertook inspection and earthworks testing for the filling placed within Stage 2 of Southlands Industrial Park. It is considered that the placement and compaction of the bulk filling and subgrade in Stage 2, placed by Enviropacific from 20 March 2015 to 12 May 2015, has been carried out in general accordance with the project requirements. Douglas Partners Pty Ltd does not undertake to guarantee the work of the contractors or relieve their responsibility to produce a completed product conforming to the project's requirements.

Development and construction of new structures on the filling should give due consideration to:

- Possible disruption of the compacted filling by installation of services.
- The possibility that additional filling has been placed after the date of the last field density test.
- Adequate lateral containment of the filling area, particularly with respect to unsupported batters.
- The suitability of the filling to support structures of various types without excessive deflection.
- Variation on filling depth.

4. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for Stage 2 of Southlands Industrial Park, McPherson Street, Banksmeadow, NSW in accordance with instructions received from Kellog Brown & Root, project managers for Orica. The work was carried out under DP's conditions of engagement. This report is provided for the exclusive use of Orica for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific testing locations, and then only to the depths tested and at the time the work was carried out.

DP's advice is based upon the conditions encountered during the placing of Stage 1. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

Yours faithfully
Douglas Partners Pty Ltd


Geoff Young
Principal

Reviewed by

R C Blinman
Principal

Attachments: Compaction Test Summary
 Drawing

Test No.	Date	Location			Field Wet Density	Peak Converted Wet Density	Density Ratio	Moisture Variation	
423	20/03/2015	Stage 2 Lot 3 Subgrade	335376	6241019	1.778	1.773	100.5	1.5	Dry
424	20/03/2015	Stage 2 Lot 3 Subgrade	335378	6241045	1.803	1.784	101.0	2.0	Dry
425	20/03/2015	Stage 2 Lot 3 Subgrade	335383	6241057	1.869	1.838	101.5	0.5	Dry
426	20/03/2015	Stage 2 Lot 3 Subgrade	335345	6241017	1.800	1.265	102.0	2.0	Dry
427	20/03/2015	Stage 2 Lot 3 Subgrade	335354	6241052	1.805	1.793	100.5	1.5	Dry
428	20/03/2015	Stage 2 Lot 3 Subgrade	335357	6241081	1.808	1.806	100.0	2.0	Dry
429	20/03/2015	Stage 2 Lot 3 Subgrade	335323	6241030	1.786	1.785	100.0	2.0	Dry
430	20/03/2015	Stage 2 Lot 3 Subgrade	335332	6241066	1.820	1.806	100.5	1.5	Dry
431	20/03/2015	Stage 2 Lot 3 Subgrade	335333	6241090	1.812	1.806	100.5	2.0	Dry
432	23/03/2015	Stage 2 Lot 3 Layer1	335367	6241024	1.907	1.910	100.0	1.5	Dry
433	23/03/2015	Stage 2 Lot 3 Layer1	335373	6241053	1.939	1.915	101.5	2.0	Dry
434	23/03/2015	Stage 2 Lot 3 Layer1	335379	6241077	1.924	1.901	101.0	2.0	Dry
435	23/03/2015	Stage 2 Lot 3 Layer1	335336	6241028	1.884	1.906	99.0	2.0	Dry
436	23/03/2015	Stage 2 Lot 3 Layer1	335339	6241057	1.901	1.908	99.5	1.5	Dry
437	23/03/2015	Stage 2 Lot 3 Layer1	335351	6241088	1.893	1.896	100.0	2.0	Dry
438	24/03/2015	Stage 2 Lot 3 Layer 2	335372	6241035	1.935	1.925	100.5	1.5	Dry
439	24/03/2015	Stage 2 Lot 3 Layer 2	335393	6241069	1.998	1.982	101.0	1.0	Dry
440	24/03/2015	Stage 2 Lot 3 Layer 2	335380	6241088	1.943	1.956	99.5	2.0	Dry
441	24/03/2015	Stage 2 Lot 3 Layer 2	335326	6241021	1.927	1.924	100.0	2.0	Dry
442	24/03/2015	Stage 2 Lot 3 Layer 2	335333	6240048	2.009	2.015	99.5	1.0	Dry
443	24/03/2015	Stage 2 Lot 3 Layer 2	335332	6241062	1.985	1.978	100.5	1.5	Dry
444	25/03/2015	Stage 2 Lot 2 Subgrade	335392	6241110	1.966	1.937	101.5	1.5	Dry
445	25/03/2015	Stage 2 Lot 2 Subgrade	335402	6241153	1.987	1.945	102.0	1.5	Dry
446	25/03/2015	Stage 2 Lot 2 Subgrade	335388	6241159	1.945	1.930	100.5	1.5	Dry
447	25/03/2015	Stage 2 Lot 2 Subgrade	335395	6241187	1.961	1.923	102.0	2.0	Dry
448	27/03/2015	Stage 2 Lot 3 Layer 3	335382	6241022	1.849	1.879	98.5	0.5	Dry
449	27/03/2015	Stage 2 Lot 3 Layer 3	335368	6241042	1.895	1.885	100.5	0.5	Dry
450	27/03/2015	Stage 2 Lot 3 Layer 3	335381	6241081	1.854	1.860	99.5	2.0	Dry
451	27/03/2015	Stage 2 Lot 3 Layer 3	335338	6241034	1.844	1.855	99.5	2.0	Dry
452	27/03/2015	Stage 2 Lot 3 Layer 3	335343	6241062	1.889	1.871	101.0	2.0	Dry
453	27/03/2015	Stage 2 Lot 3 Layer 3	335347	6241088	1.904	1.891	100.5	2.0	Dry
454	30/03/2015	Stage 2 Lot 3 Est Bay L1	335399	6241039	1.811	1.815	100.0	2.0	Dry
455	30/03/2015	Stage 2 Lot 3 Est Bay L1	335398	6241071	1.840	1.835	100.0	2.0	Dry
456	30/03/2015	Stage 2 Lot 3 Est Bay L1	335405	6241119	1.804	1.820	99.0	2.0	Dry
457	30/03/2015	Stage 2 Lot 2 Subgrade	335371	6241121	1.871	1.850	101.0	1.5	Dry
458	30/03/2015	Stage 2 Lot 2 Subgrade	335375	6241143	1.807	1.803	100.0	2.0	Dry
459	30/03/2015	Stage 2 Lot 2 Subgrade	335381	6241187	1.815	1.817	100.0	2.0	Dry
460	9/04/2015	Stage 2 Lot 3 East Bdy L2	335400	6241049	1.942	1.938	100.0	1.5	Dry
461	9/04/2015	Stage 2 Lot 3 East Bdy L2	335401	6241087	1.938	1.981	98.0	1.0	Dry
462	9/04/2015	Stage 2 Lot 3 East Bdy L2	335410	6241119	1.945	1.947	100.0	2.0	Dry
463	9/04/2015	Stage 2 Lot 3 East Bdy L2	335412	6241153	1.951	1.989	98.0	2.0	Dry
464	10/04/2015	Stage 2 Subgrade Lot 2 (West)	335323	6241151	1.888	1.883	100.0	0.5	Dry
465	10/04/2015	Stage 2 Subgrade Lot 2 (West)	335305	6241196	1.965	1.962	100.0	2.0	Dry
466	10/04/2015	Stage 2 Subgrade Lot 2 (West)	335298	6241219	1.885	1.866	101.0	1.0	Dry
467	10/04/2015	Stage 2 Subgrade Lot 2 (West)	335294	6241238	1.933	1.928	100.5	1.0	Dry
468	13/04/2015	Stage 2 Lot 2 Layer1	335361	6241155	1.807	1.824	99.0	1.1	Dry
469	13/04/2015	Stage 2 Lot Layer 1	335341	6241205	1.833	1.836	100.0	1.0	Dry
470	13/04/2015	Stage 2 Layer 1 (west)	335312	6241154	1.963	1.972	99.5	0.0	OPT
471	13/04/2015	Stage 2 Lot 2 Layer 1	335305	6241208	1.883	1.905	99.0	1.5	Dry
472	13/04/2015	Stage 2 Lot 1 Subgrade	335278	6241293	1.825	1.813	100.5	2.0	Dry
473	13/04/2015	Stage 2 Lot 1 Subgrade	335276	6241316	1.813	1.803	100.5	2.0	Dry
474	13/04/2015	Stage 2 Lot 1 Subgrade	335305	6241321	1.819	1.811	100.5	1.0	Dry
475	14/04/2015	Stage 2 Lot 2 Subgrade	335343	6241264	1.848	1.834	100.5	0.0	Opt
476	14/04/2015	Stage 2 Lot 2 Subgrade	335329	6241281	1.816	1.803	100.5	1.0	Dry
477	14/04/2015	Stage 2 Lot 2 Subgrade	335301	6241280	1.822	1.810	100.5	1.0	Dry
478	14/04/2015	Stage 2 Lot 3 East Bdy L3	335401	6241649	1.980	1.999	99.0	2.0	Dry
479	14/04/2015	Stage 2 Lot 3 East Bdy L3	335403	6241097	2.003	2.010	99.5	1.5	Dry
480	14/04/2015	Stage 2 Lot 3 East Bdy L3	335408	6241143	2.003	1.976	98.5	1.5	Dry
481	16/04/2015	Stage 2 Lot 1 S.East L1	335291	6241283	1.802	1.820	99.0	2.0	Dry
482	16/04/2015	Stage 2 Lot 1 S.East L1	335264	6241291	1.791	1.818	98.5	2.0	Dry
483	16/04/2015	Stage 2 Lot 1 S.East L1	335288	6241313	1.810	1840	98.5	2.0	Dry
484	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335186	6241339	2.077	1.967	105.5	1.5	Dry
485	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335206	6241362	1.869	1825	102.5	0.5	Dry
486	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335215	6241345	1.755	1748	100.0	0.5	Wet

Test No.	Date	Location			Field Wet Density	Peak Converted Wet Density	Density Ratio	Moisture Variation	
487	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335238	6241364	1.846	1837	100.5	0.5	Dry
488	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335247	6241340	1.918	1887	101.5	0.5	Dry
489	27/04/2015	Stage 2 Lot 1 Nth Subgrade	335275	6241364	1.772	1761	100.5	0.5	Wet
490	28/04/2015	Stage 2 Lot 2 East Layer 1	335380	624188	1.895	1911	99.0	0.5	Dry
491	28/04/2015	Stage 2 Lot 2 East Layer 1	335363	6241204	1.928	1925	100.0	0.5	Dry
492	28/04/2015	Stage 2 Lot 2 East Layer 1	335362	6241227	1.927	1965	98.0	0.0	OPT
493	29/04/2015	Stage 2 Lot 2 West Layer 2	335312	6241177	1.905	1928	99.0	0.5	Dry
494	29/04/2015	Stage 2 Lot 2 West Layer 2	335311	6241208	1.944	1976	98.5	0.5	Wet
495	29/04/2015	Stage 2 Lot 2 West Layer 2	335295	6241233	1.960	1996	98.5	1.0	Dry
496	7/05/2015	Stage 2 Lot 3 Eastern Bdy L4	335394	6241016	1.817	1.855	98.0	1.5	Dry
497	7/05/2015	Stage 2 Lot 3 Eastern Bdy L4	335401	6241070	1.801	1.826	98.5	1.5	Dry
498	7/05/2015	Stage 2 Lot 3 Eastern Bdy L4	335408	6241138	1.783	1.822	98.0	1.5	Dry
499	8/05/2015	Stage 2 Lot 1 Eastern Bdy L1	335325	6241322	1.867	1.884	99.0	2.0	Dry
500	8/05/2015	Stage 2 Lot 1 Eastern Bdy L1	335321	6241348	1.839	1.873	98.0	2.0	Dry
501	8/05/2015	Stage 2 Lot 1 Eastern Bdy L1	335312	6241376	1.943	1.890	99.5	2.0	Dry
502	11/05/2015	Stage 2 Lot 1 South L1	335273	6241277	1.873	1.901	98.5	1.5	Dry
503	11/05/2015	Stage 2 Lot 1 South L1	335282	6241296	1.845	1.885	98.0	2.0	Dry
504	11/05/2015	Stage 2 Lot 1 South L1	335256	6241300	1.817	1.856	98.0	2.0	Dry
505	12/05/2015	Stage 2 Lot 2 Eastern Bdy L1	335387	6241215	1.865	1.879	99.5	1.5	Dry
506	12/05/2015	Stage 2 Lot 2 Eastern Bdy L1	335357	6241255	1.850	1.854	100.0	2.0	Dry
507	12/05/2015	Stage 2 Lot 2 Eastern Bdy L1	335335	6241280	1.835	1.868	98.0	1.5	Dry
508	12/05/2015	Lot 2 North	335312	6241275	1.844	1.883	98.0	1.5	Dry

