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23 December 2020

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By email: Chris.Dury@sparke.com.au

Dear Chris,

Jordan Springs East (JSE), Penrith

1. Further to your request, you have asked the writers for a joint answer to the question "Is the fill at Jordan Springs East Development controlled fill or uncontrolled fill?"

2. We confirm that we are aware of the instructions of the Expert Witness Code of Conduct, Uniform Civil Procedure Rules (UCPR) in Part 31 Division 2, and the Expert Witness Code of Conduct, Schedule 7 of the UCPR, and that these have been read and understood. The writers are specialists in the field of geotechnical engineering, with particular expertise in unsaturated soil mechanics.

3. The following is given:

Documents Received

4. A series of reports on the current nature of the existing deep fill at Jordan Springs East (JSE) have been prepared. Those reports referred to in preparation of this response are as follows:

[redacted]

o) Penrith City Council Determination of Development Application DA14/1228.02 25 August 2015 to 25 August 2017,
p) Penrith City Council "Design Guidelines for Engineering Works for Subdivisions and Developments", Amended 20 November 2013,
q) Penrith City Council "Engineering Construction Specification for Civil Works", Amended 22 June 2016,

Classification of sites with deep fill

5. The default classification for a site with fill of material, other than sand, and deeper than 400 mm is Class P in accordance with AS2870 - Section 2.5.3(b). However, Section 2.5.3(c) of the Standard permits "*a site with controlled fill, and classified P may be given an alternative site classification in accordance with Table 2.1 if assessed in accordance with engineering principles. The assessment shall consider the movement of the fill and the underlying soil from the condition at construction to the long-term equilibrium moisture conditions*".

6. The provision in Section 2.5.3(c) is the basis for Pells Sullivan Meynink (PSM) proposed methodology for lot re-classifications at JSE (Reference b).

7. The key qualifiers in Section 2.5.3(c) are: a) controlled fill, and b) assessment in accordance with engineering principles.

8. Uncontrolled fills, due to their variability and lack of control, are not amenable for assessment in accordance with engineering principles. Assessment of sites based on engineering principles is typically based on a discrete and localised determination of soil properties at several points, and extrapolation of those properties between the points. Such extrapolation is not possible in uncontrolled fills due to their inherent spatial variability. The writers are not aware of any documented cases in the literature, or engineering practice, that settlement behaviour of an uncontrolled fill has been predicted successfully using engineering principles.

9. The classification of a site with uncontrolled fill deeper than 400 mm for material other than sand is Class P in accordance with AS 2870. It is therefore important to determine if the fill at JSE is controlled fill or uncontrolled fill.

Is the fill at JSE controlled?

10. AS2870 – Section 1.8.13 defines controlled fill as *"fill that will be required to support structures or associated pavements, or for which engineering properties are to be controlled"*. AS2870 – Section 2.5.3 states *"For the purposes of this Standard, fill that is in accordance with the technical and control requirements specified in AS3798 for structural fill for residential applications is controlled fill. Other fill is uncontrolled fill for the purposes of this Standard."*

11. The consent conditions specified by the Penrith City Council for the bulk earthworks at JSE are given in Reference (o), and in Paragraph 41 these are stated as "*All earthworks shall be undertaken in accordance with AS 3798 and Penrith City Council's Design Guidelines for Engineering Works for Subdivisions and Developments, Engineering Construction Specification for Civil Works."*

12. The Penrith City Council's Design Guidelines for Engineering Works for Subdivisions and Developments (Reference p) states in Section 1.9.3 for Lot Filling/Grading, that "*Works are to be carried out in accordance with the requirements of Section 4.6 of Penrith City Council's 'Engineering Construction Guidelines for Civil Works'.*"

13. Section 4.6 of Penrith City Council's 'Engineering Construction Guidelines for Civil Works' (Reference q) states that "*Filling shall be carried up in horizontal layers, extend the full width of the area being filled, of not more than 300 mm loose thickness. Each layer shall be compacted to a density ratio of at least 95% Standard, using AS 1289.5.4.1 (2007) – 'Methods of Testing Soils for Engineering Purposes'. The depths of fill and the compaction thereof are to be verified by the submission of compaction certificates from a N.A.T.A. registered laboratory, and a plan showing contoured depths of fill in relation to lot boundaries. Frequency of testing and treatment of failed areas to be in accordance with AS 3798 (2007) – 'Guidelines on Earthworks for Commercial and Residential Developments'.*"

14. An earthworks specification for JSE was also prepared by Douglas Partners (Reference f). This specification meets the minimum requirements set out in AS3798. Specifically, it

    i) Requires "*Spreading of material in uniform, horizontal layers in maximum loose thickness layers of 300 mm. Layer thicknesses of up to 500 mm loose thickness are permitted provided that the Contractor demonstrates compliance with the minimum compaction criteria throughout the full depth of the layer. Spreading shall achieve good distribution and shall avoid segregation or pockets of nonhomogeneous material. Layers of material shall not differ substantially from surrounding material and the density shall be uniform throughout each compacted layer.".*
    ii) Limits maximum particle size to *"150 mm for layer thickness of up to 300 mm, otherwise 200 mm for layer thicknesses of up to 500 mm, inclusive of the removal of steel reinforcement.".*
    iii) Identifies unsuitable material as: a) *"Soils with vegetation including tree stumps, roots, high root fibre content or other organic matter"*, b) *"Silts or soils with a predominant portion of silt", and c) "Ripped rock comprising oversize material with particle sizes of greater than 150 mm or half of the compacted layer thickness (i.e., following compaction).".*
    iv) Sets compaction level to *"Structural / Engineered Filling (Residential Lots) - Minimum 95% SMDD (AS 1289.5.1.1), or 95% Hilf density ratio (AS 1289.5.7.1), or 65% DI (AS 1289.5.6.1).".*
    v) Requires compaction moisture content to be *"Structural / Engineered Filling (Residential Lots) +/- 2% of Standard Optimum Moisture Content or maximum +/- 2% Hilf moisture variation.".*
    vi) *Specifies the minimum frequency of testing.*

15. The writers are of the opinion that if the earthworks at JSE were carried out in accordance with the consent conditions of the Penrith City Council, so that by Section 4.6 of Reference (q), the layer thickness did not exceed 300 mm loose thickness, compacted to 95% standard, with the frequency of testing in accordance with AS 3798-2007, and by AS 3798, the elimination of unsuitable fill materials and ensuring uniformity of materials, then the fill would be classified as "controlled fill", meeting the requirements of AS2870-2011, Sections 1.8.13, and 2.5.3.

16. It is also the writers' opinion that if the earthworks at JSE were carried out in accordance with the Douglas Partners Specification (Reference f), so that the layer thickness did not exceed

300 mm loose thickness, confirmatory testing conducted to verify minimum compaction criteria throughout the full depth of the layer if the layer thickness exceeded 300 mm and up to 500 mm loose thickness, minimum density ratio 95% standard, with the frequency of testing in accordance with AS 3798-2007, the elimination of unsuitable fill materials and ensuring uniformity of materials, then the fill would be classified as "controlled fill", meeting the requirements of AS2870-2011, Sections 1.8.13, and 2.5.3.

17. We have identified many instances where significant departures from the consent conditions of the Penrith City Council (Reference o), and from the Douglas Partners Specification (Reference f), have occurred at JSE. These are related to the loose layer thickness in many locations exceeding the 300 mm maximum specified, no confirmatory testing conducted to verify minimum compaction criteria throughout the full depth of the layer if the layer thickness exceeded 300 mm loose thickness, the frequency of testing being less than the minimum requirements of AS 3798-2007, the spacial variability of the fill, the presence of unsuitable fill materials, and less than adequate level of compaction. These departures from the consent conditions of the Penrith City Council and the Douglas Partners Specification, means that some sections of the fill at JSE contain uncontrolled earthworks.

18. Our reasons for arriving at this opinion are outlined in the following sections.

Frequency of Testing

19. The consent conditions of the Penrith City Council (Reference o) require the minimum frequency of testing to be in accordance with AS 3798-2007. AS3798-2007 lists minimum frequency of testing for control requirements for structural fill in Table 8.1 as shown below for the large-scale operations at JSE. It is seen that the frequency of testing is a maximum of either 1 test per layer per material type per 2500 m^2; 1 test per 500 m^3 evenly distributed; or 3 tests per lot. This implies that for a maximum loose layer thickness of 300 mm (say 250 mm compacted thickness), the minimum frequency of tests will be 1 test per 500/0.25 = 1 test per 2000 m^2 per layer.

TABLE 8.1

FREQUENCY OF FIELD DENSITY TESTS

Type of earthworks	Frequency of tests (see Note 2)
Type 1 Large scale operations (greater than 1500m^2 e.g., subdivisions, large industrial lots, road embankments)	1 test per layer per material type per 2500m^2; *or* 1 test per 500m^3 distributed reasonably evenly throughout full depth and area; *or* 3 tests per lot (Clause 1.2.8)
	Whichever requires the most tests

20. The Douglas Partners Specification (Reference f) has a more frequent testing requirement of 1 test per 1500 m^2 as shown in Table 4 below.

Table 4: Compaction Testing Frequency

Material / Layer	Compaction Test Frequency
Structural / Engineered Filling (Residential Lots)	1 test per layer per material type per 1500 m^2, or 1 test per 500 m^3 evenly distributed

21. As outlined in the following sections, we have found that the frequency of testing in sections of JSE is much less than the minimum of 1 test per 2000 m^2 per layer by AS 3798 or the minimum 1 test per 1500 m^2 per layer by the Douglas Partners Specification, indicating departure from the requirements of the Penrith City Council's consent conditions (Reference o) and the Earthworks Specification by Douglas Partners (Reference f).

Unsuitable Materials

22. As outlined in Paragraph 11, the consent conditions of the Penrith City Council (Reference o) require that "*All earthworks shall be undertaken in accordance with AS 3798…….".*

23. Section 4.3 of AS 3798-2007 states that "*Some materials are unsuitable for forming structural fill and should either be removed to spoil or used in non-critical areas. Unsuitable materials may include .....fill that contains wood, metal, plastic, boulders or other deleterious material, in sufficient proportions to affect the required performance of the fill.*"

24. Douglas Partners Specification (Reference f) identifies unsuitable material as: a) *"Soils with vegetation including tree stumps, roots, high root fibre content or other organic matter"*, b) *"Silts or soils with a predominant portion of silt", and c) "Ripped rock comprising oversize material with particle sizes of greater than 150 mm or half of the compacted layer thickness (i.e., following compaction).".*

25. As outlined in the following sections, we have found that significant sections of JSE contain unsuitable materials for structural fill, indicating departures from the requirements of the Penrith City Council's consent conditions (Reference o**)** and the Douglas Partners Earthworks Specification (Reference f).

Actual placement layer thickness

26. The fill layer thickness (the 'lifts') at JSE were reported to be as deep as 500 mm (e.g., References g, h, i, j, k, l, m and n). These references state that *"Filling was placed in layer thicknesses of 300 mm to 500 mm across the filling area".*

27. References g, h, i, j, k, l, m, and n also state that "*Each [field density] test was performed on a cut pad created generally 50 mm below the filling surface".* This means that the tests were only taken at the top of each layer of fill. The requirement of AS 3798-2007 and the Douglas Partners Earthworks specification, for confirmatory testing to be conducted to verify minimum compaction criteria throughout the full depth of the layer if the loose layer thickness exceeded 300 mm thickness, was not carried out.

28. At JSE, although lifts of up to 500 mm thickness were constructed, no testing was conducted to ensure that the base of each layer was compacted to the specified relative compaction. Therefore, layers of fill of less than adequate compaction have the potential to occur in the lower sections of each lift where the lift thickness exceeded 300 mm loose thickness.

Armoury Road Affected Area

29. In References (b), (c), and (d), PSM identified an area in JSE, termed the Armoury Road Affected Area (ARAA), where settlements of roads and residential structures were significantly high. The settlement of Armoury Road north-east of the Navy Road roundabout was reported, in Reference (e), to be 180 mm to 245 mm over the period February 2017 to May 2020. Two adjacent houses (at Lots 1186 and 1213) were reported in Reference (s) to have been demolished because of the excessive ground settlement.

30. References (a), (b), (c), and (d), indicate that the excessive settlement in sections of the ARAA has resulted from the early earthworks in the ARAA which comprised a significant volume of fill being placed rapidly, with little to no compaction or earthworks control testing.

31. In Reference (b), of the ninety-eight (98) allotments within the ARAA, eighty-five (85) were given a site classification of "Class P – Problem site", indicating extensive uncontrolled fill being present.

32. The ARAA forms parts of Zones EW2.1, EW4.1 and EW4.2, and the Douglas Partners earthworks reports for these zones (References h, i, and j) states "*It is considered that the placement and compaction of the bulk filling by Lend Lease Engineering Pty Ltd …… has been carried out in general accordance with the project specification and the requirements of Penrith City Council*". The Douglas Partners site classification reports dated April 2017 for Lots 1186 and Lot 1213 where the houses were subsequently demolished, and for the adjacent allotments (Reference t), stated that the fill was controlled fill.

33. These Douglas Partners reports for this part of JSE have been proven to be inaccurate and therefore cannot be relied upon.

34. The writers have confirmed that little or no testing was carried out for an appreciable volume of fill in the ARAA, by taking an area of about 4,400 m^2 bounded by the dashed line as shown in Figure 1.

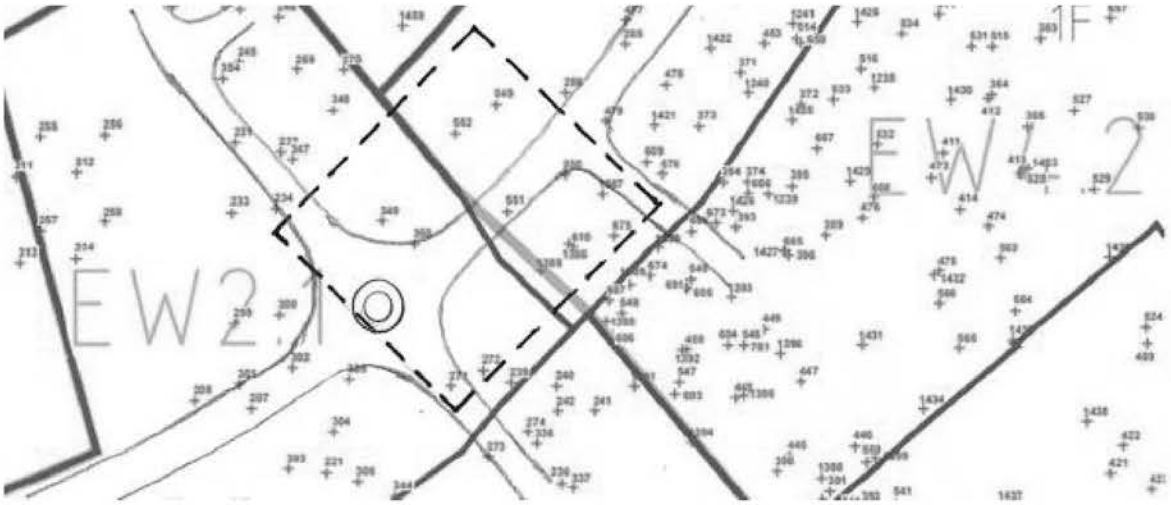

Figure 1: Area in ARAA, centred by Armoury Road, north-east of the Navy Road roundabout within Stages EW2.1 and EW 4.2, where compaction test results within the fill were examined

35. Within the dashed area shown in Figure 1, we have examined from References (h) and (j), the compaction test result at every location tested.

36. Reference (a), indicates that in this area of JSE, the final ground surface is at about RL 24.2m, the general base if the fill is at about RL 20.2 m, and that a former channel was present, the base of which was at about RL 18.0 m.

37. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined. A total of 13 tests was carried out, which were all examined.

38. The results are shown in Figure 2 as a graph of density ratio with RL.

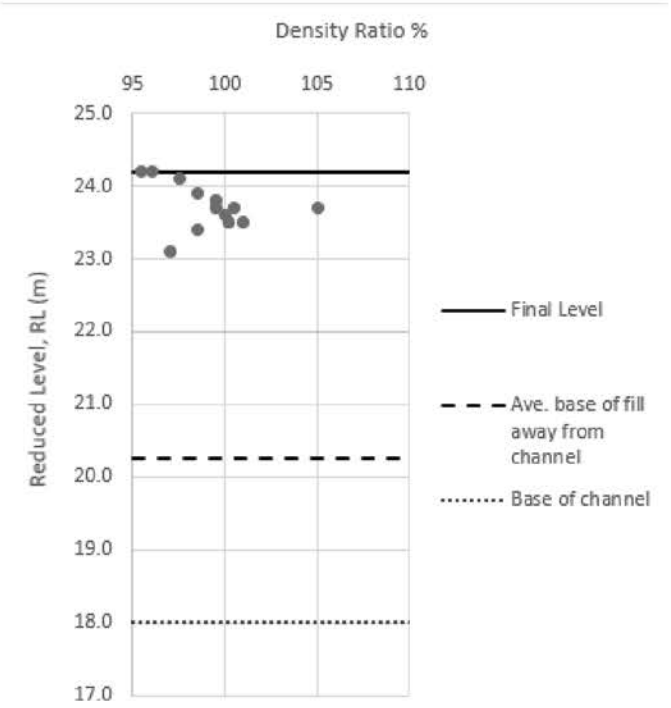

Figure 2: Density Ratio vs RL for all tests within the dashed area shown in Figure 1

39. It can be seen from Figure 2, no tests were carried out in this area of JSE for the lower 5 m of fill, and that the only compaction tests that were carried out were confined to approximately the upper 1 m of the fill.

40. For an area of 4,400 m^2, the Douglas Partners specification requirement of 1 test per layer per 1500 m^2 means that 4400/1500 ≈ 3 tests per layer are needed. For a fill thickness of 5 m and a compacted layer thickness of 250 mm, the number of layers is 5000/250 = 20. Therefore, the Douglas Partners specification requires the number of tests over this 5 m depth of fill should have been about 20 layers x 3 tests/layer = 60 tests, rather than no tests.

41. This indicates that deep fill was placed in the Armoury Road area without the testing as required by the earthwork's specifications. The compaction and quality of this deep fill is therefore unknown. The Douglas Partners Earthworks certifications (References h and j), at least in this area of JSE, therefore do not give an accurate indication of the actual condition of the fill, and so are unreliable.

Report by Public Works Advisory (PWA)

42. Reference (u) is a desktop peer review by PWA of the reports that present geotechnical information of the fill platform at JSE. This report demonstrates that at least sections of the fill platform within the JSE contain uncontrolled earthworks including fill of low relative compaction. Examples include: end-tipped fill with little or no compaction and open voids; fill that has received little or no moisture conditioning and does not conform to the minimum moisture content requirements; the presence of unsuitable material such as concrete, wood, organic matter, and boulders; non-homogeneous material, including layers of fill material differing substantially from surrounding material and variable density throughout each compacted layer.

43. Examples of inadequate compaction (indicated by voids) and unsuitable earthwork materials reported by Reference (u) are shown in the photographs below.

Photograph 9 – Photograph taken from within the excavation for the Armoury Road remedial works located north-east of the Armoury Road / Navy Road roundabout within Stage 1 of JSE. View of the state of the fill material including possible voids and sandstone boulders within the fill

Photograph 14 – Photograph taken from within the excavation for the Armoury Road remedial works located north-east of the Armoury Road / Navy Road roundabout within Stage 1 of JSE. View of the state of the fill material including sandstone boulders and plastic within the fill

44. The examples of poor compaction reported by PWA in Reference (u) are not limited to Armoury Road Affected Area (ARAA).

45. The writers have also found examples of sites outside the ARAA where significant departures from the project earthwork's specifications occurred. These sites were forwarded by the Penrith City Council to the second writer for a geotechnical review as part of the building approval process.

Lot 3022 (No. 16) Poynting Street

46. Lot 3022 Poynting Street is in stage EW6.1, at the boundary with EW6.2. The site is known to straddle over a back-filled unnamed channel, orientated roughly in a north-south direction, as shown in Figure 3. Figure 3 also shows the locations of compaction tests in the vicinity of Lot 3022.

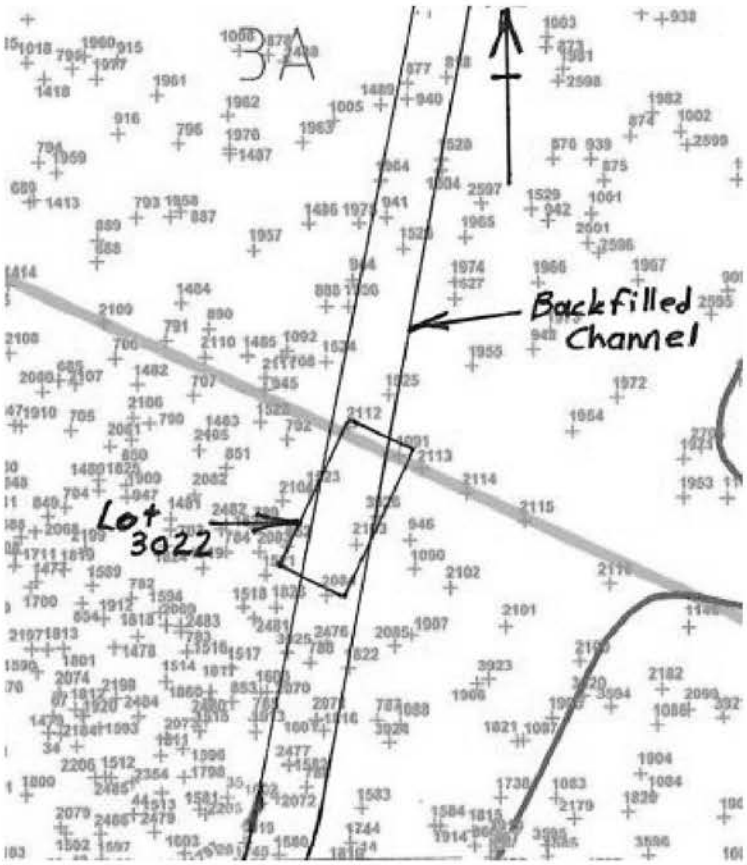

Figure 3: Area within Stages EW6.1 and EW 6.2, and approximately centred by Lot 3022, where compaction test results within the backfilled channel were examined

47. A site-specific geotechnical investigation for Lot 3022 was conducted at the site (Reference v), and from the results of five (5) boreholes, it was found that the depth of fill was up to 8 m, and the fill material was predominately a silty sand.

48. Reference (e) indicates that one point on the kerb adjacent Lot 3022 has settled 61 mm over the period April 2018 to August 2020, and is currently settling at the average rate of 1 mm/month.

49. It is understood from Reference (l), that the average level of the ground surface at Lot 3022 is about RL 24 m, and the depth of the fill away from the channel in Lot 3022 is about 5.5 m.

50. Within an approximate 2500 m^2 area of the backfilled former channel, approximately centred by Lot 3022 as shown in Figure 3, we have determined from References (l) and (m), the compaction test result at every location tested. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test was determined. A total of 20 tests was carried out, which were all examined.

51. The results are shown in Figure 4 as a graph of density ratio with RL.

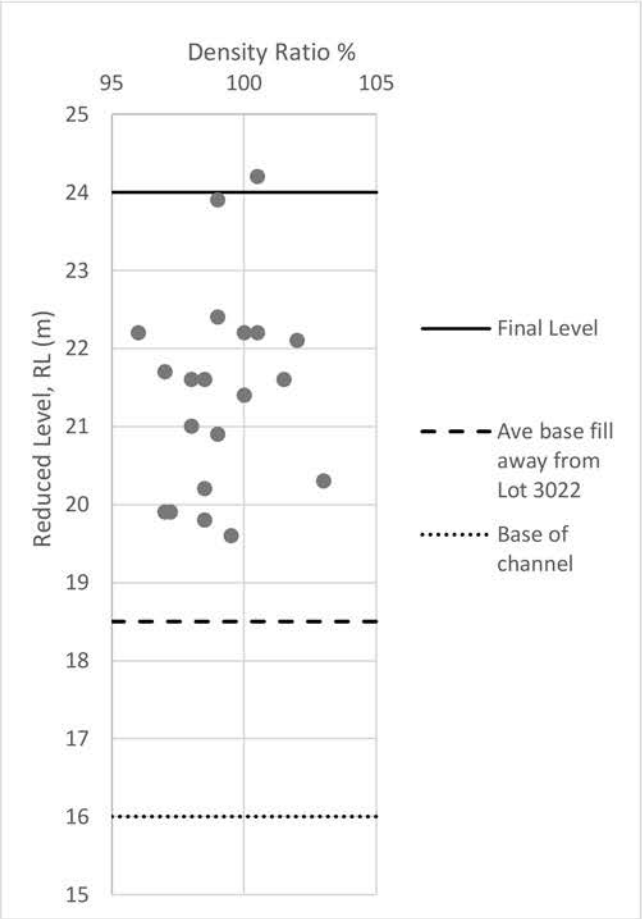

Figure 4: Density Ratio vs RL for all tests within backfilled channel in the vicinity of Lot 3022 (see Figure 3)

52. From Figure 4, for the ground surface at RL 24 m, for up to an 8 m depth of fill, the base of the fill will be at about RL 16 m. No tests have been conducted in the lower 2.5 m of fill in the channel.

53. By the Douglas Partners specification requirement of 1 test per layer per 1500 m^2, for a compacted layer thickness of 250 mm, the number of tests required over the 2500 m^2 area for this lower 2.5 m depth of fill, is (2500/1500) x (2500/250) ≈ 17, rather than no tests.

54. Therefore, it is concluded that the backfilling, at least in the deeper sections of the channel, was not carried out with the testing required by the earthwork's specifications.

Lot 1307 Colonel Way

55. Lot 1307 Colonel Way is at the south-eastern corner of stage EW4.2, just outside the ARRA area. The location is shown in Figure 5. Figure 5 also shows the locations of compaction tests (from Reference j) in the vicinity of Lot 1307.

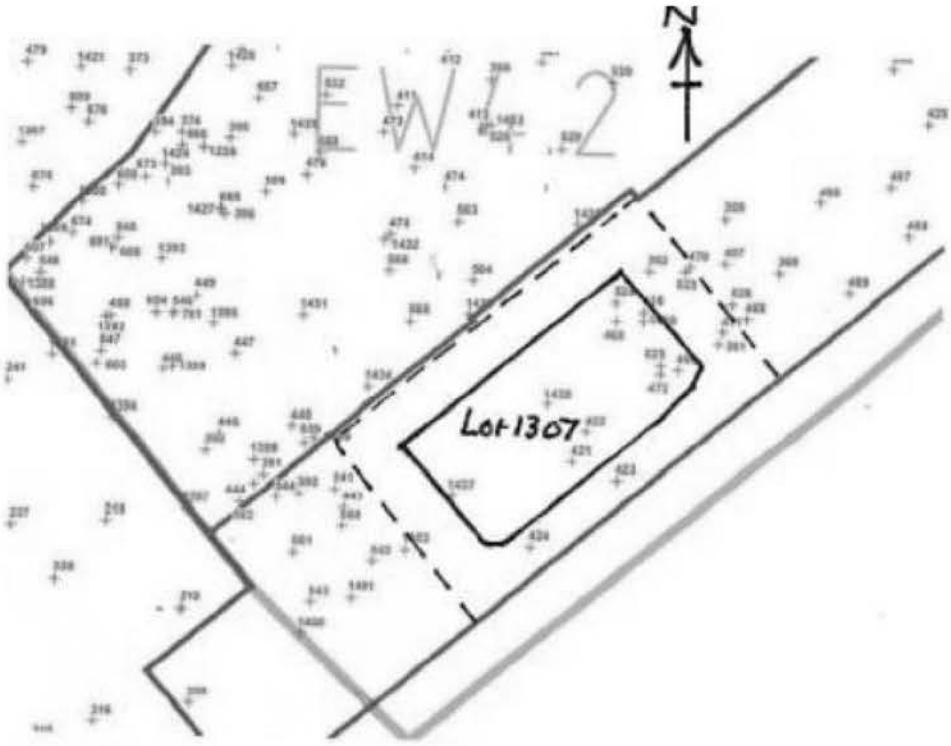

Figure 5: Area within Stage EW4.2, and approximately centred by Lot 1307 where compaction test results were reported

56. A site-specific geotechnical investigation for Lot 1037 has been conducted at the site (Reference w), and from the results of six (6) boreholes, the site contains fill of a depth 3.3 m to 3.7 m.

57. It is understood from Reference (x), that the average level of the ground surface at Lot 1307 is about RL 22.5 m.

58. Within an area of about 4,500 m^2 bounded by the dashed line and approximately centred by Lot 1307 as shown in Figure 5, we have determined from Reference (j), the compaction test result at every location tested.

59. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined. A total of 18 tests was carried out, which were all examined.

60. The results are shown in Figure 6 as a graph of density ratio with RL.

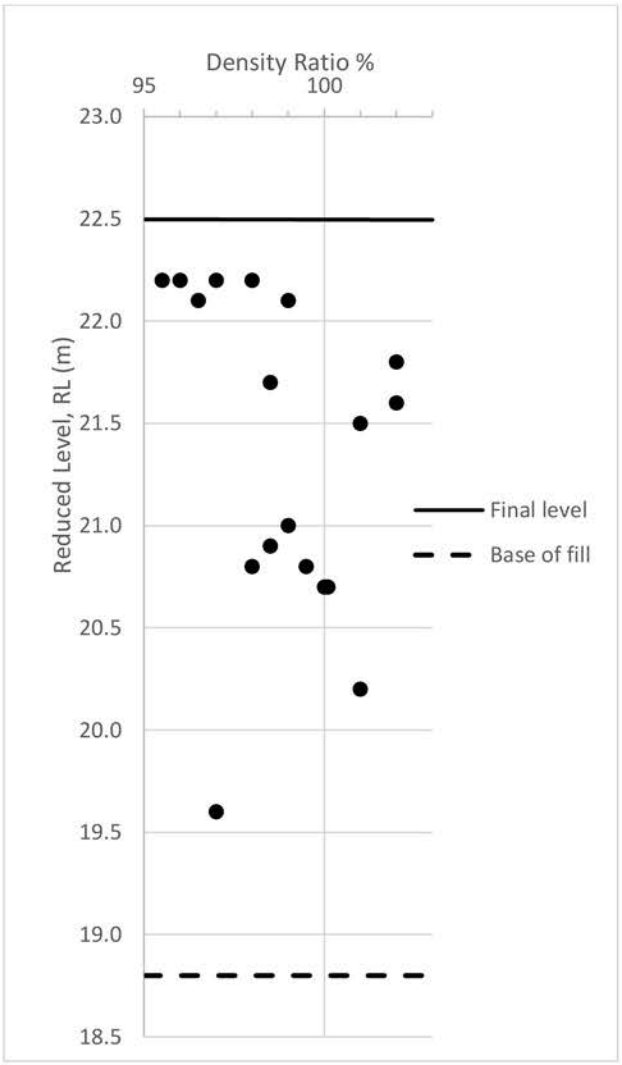

Figure 6: Density Ratio vs RL for all tests within the vicinity of Lot 1307 (see Figure 5)

61. Several conclusions are made from Figure 6 as follows:
    - For a ground surface at RL 22.5 m, and for up to a 3.7 m depth of fill, the base of the fill will be at about RL 18.8 m. No tests have been conducted in the lower 800 mm of fill. For this area of 4,500 m^2 and a compacted layer thickness of 250 mm, by the Douglas Partners specification of 1 test per layer per 1500 m^2, the number of tests required over this 800 mm depth of fill is (4500/1500) x (800/250) ≈ 10,
    - Only 2 tests over the entire area have been carried out below RL 20.7 m (i.e., all but 2 tests have been carried out in the upper 1.8 m of fill). For this area of 4,500 m^2 and a compacted layer thickness of 250 mm, by the Douglas Partners specification of 1 test per layer per 1500 m^2, the number of tests required over this lower 1.9 m depth of fill is (4500/1500) x (1900/250) ≈ 23, and
    - The lift thickness appears to be up to about 500 to 800 mm.

62. It can be concluded from Figure 6 that the earthworks, at least at several locations in the area of Lot 1307, was not in accordance with the earthwork's specifications, as there were insufficient tests. The level of fill compaction is therefore unknown at several locations at this site.

Lot 1026 (No. 14) Ashgrove Close

63. Lot 1026 is located at the northern edge of Stage EW1, as shown in Figure 7. Figure 7 also shows the locations of compaction tests (from Reference g) in the vicinity of Lot 1026.

64. From Reference (y), the depth of fill on this allotment varies up to 1.5 m and the ground surface is at about RL 28.5 m.

65. Within the area of about 10,000 m^2 including and surrounding Lot 1026 as shown bounded by the dashed line in Figure 7, we have determined from Reference g, the compaction test result at every location tested.

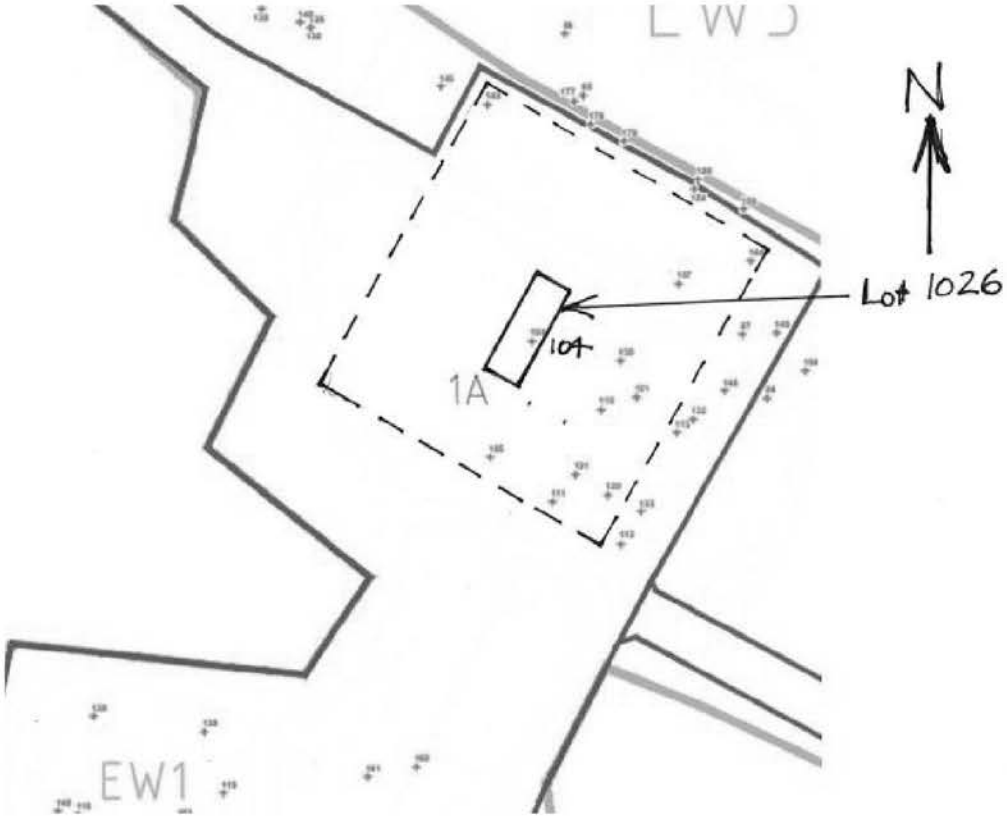

Figure 7: Area within Stage EW1, and approximately centred by Lot 1026 where compaction test results were examined

66. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined. A total of 11 tests was carried out, which were all examined.

67. The results are shown in Figure 8 as a graph of density ratio with RL.

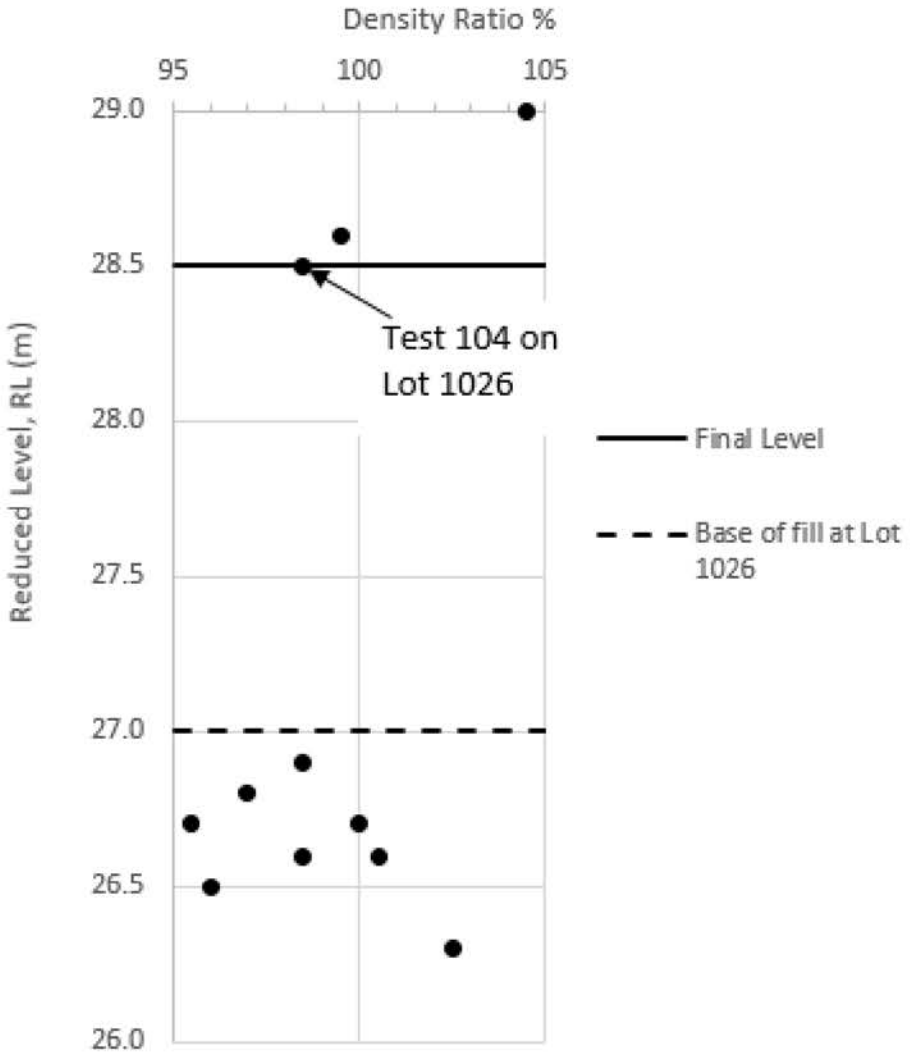

Figure 8: Density Ratio vs RL for all tests within the vicinity of Lot 1026 (see Figure 7)

68. Several conclusions are made from Figure 8 as follows:

- Only one test (test 104) was carried out on the actual allotment, and this was taken at the top of the fill, and
- No tests are reported for up to about 1.6 m thickness of the fill. As the fill thickness on Lot 1026 is up to about 1.5 m, this is a serious inadequacy.

69. For the area of 10,000 m^2 considered here, and an average fill thickness of 1.5 m, for a compacted layer thickness of 250 mm, the Douglas Partners specification of 1 test per layer per 1500 m^2 requires the number of tests to be (10000/1500) x (1500/250) ≈ 40.

70. It is concluded from Figure 8 that the earthworks, at least in the area of Lot 1026, had insufficient testing during construction, so that the quality of the fill is unknown for considerable sections.

Lot 3125 (No. 2) Bravo Street

71. Lot 3125 is located within Stage EW7, as shown in Figure 9. Figure 9 also shows the locations of compaction tests (from Reference n) in the vicinity of Lot 3125.

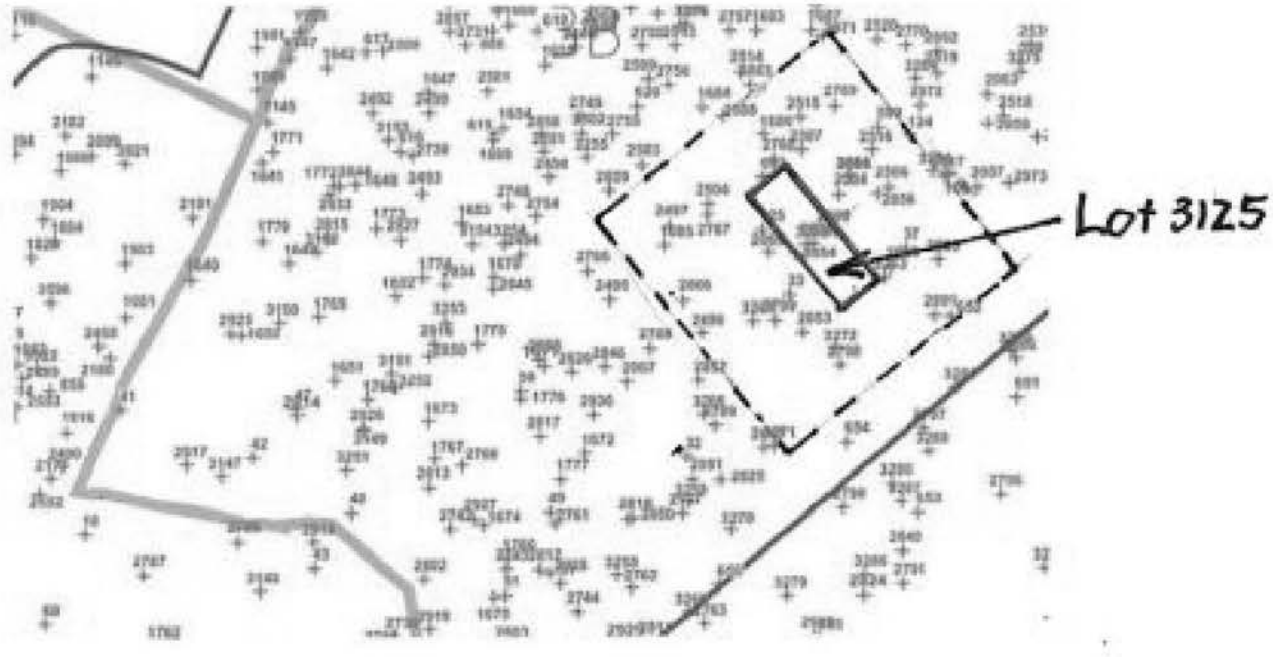

Figure 9: Area within Stage EW 7, and approximately centred by Lot 3125 where compaction test results were examined

72. In Reference (z), STS Geotechnics have found by means of two boreholes, that the site contains up to at least 5.1 m of fill materials. One of the boreholes could not penetrate the fill below a depth of 4.5 m.

73. It is understood from Reference (n), that the final ground surface at Lot 3125 is about RL 22.7 m.

74. Within an area of about 3,100 m^2, approximately centred by Lot 3125 as shown in Figure 9, the writers have determined, from Reference (n), the compaction test result at every location tested.

75. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined.

76. A total of 43 tests was carried out, which were all examined.

77. The results are shown in Figure 10 as a graph of density ratio with RL.

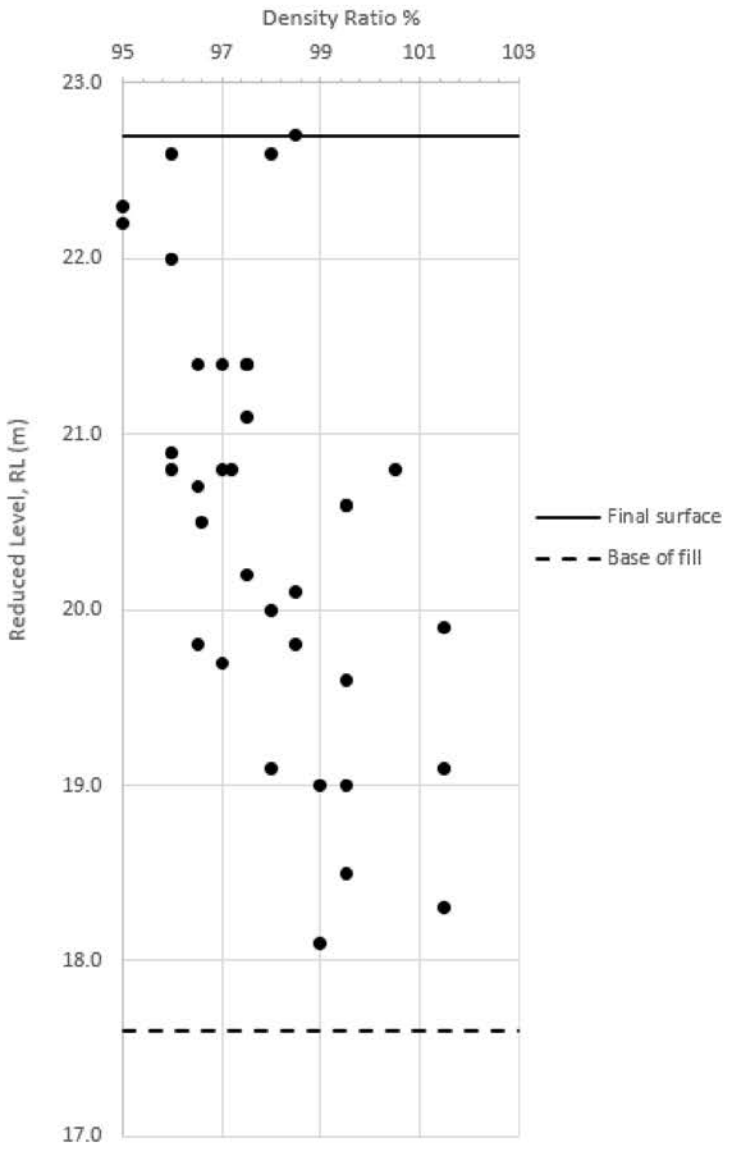

Figure 10: Density Ratio vs RL for all tests within area shown in Figure 9

78. Several conclusions are made from Figure 10 as follows:

- For a 5.1 m depth of fill, and a ground surface at RL 22.7 m, the base of the fill will be at about RL 17.6 m. Only 3 tests over the 3100 m^2 area were carried out below RL 19 m (i.e., the lower 1.4 m of fill). By the Douglas Partners earthwork's specification of 1 test per layer per 1500 m^2, for a compacted layer thickness of 250 mm, at least about 11 tests (i.e., [3100/1500] x [1400/250]) should have been taken in the lower 1.4 m of fill, and
- The lift thickness appears to be up to about 500 mm to 600 mm. This lift thickness exceeds the maximum specified without confirmatory tests that the compaction is uniform over this layer thickness.

79. These observations indicate departures from the earthwork's specification, particularly at the lower levels of the fill, meaning that there is uncertainty on the quality of earthworks at these levels.

Lot 3044 Armoury Road

80. Lot 3044 is located within Stage EW6.2, as shown in Figure 11. Figure 11 also shows the locations of compaction tests (from Reference m) in the vicinity of Lot 3044.

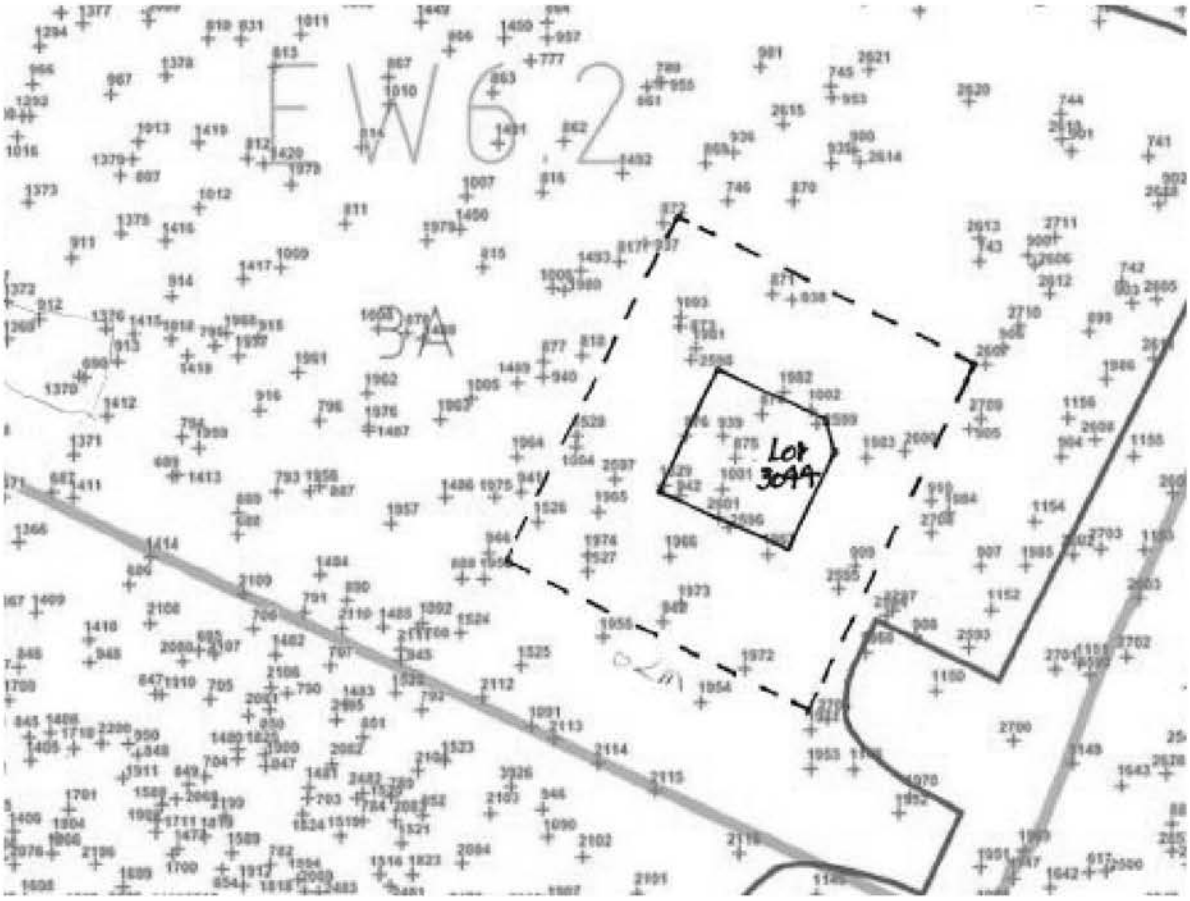

Figure 11: Area within Stage EW 6.2, and approximately centred by Lot 3044 where compaction test results were examined

81. It is understood from Reference (m), that the final level of the ground surface at Lot 3044 is about RL 23.5 to RL 24.0 m.

82. In Reference (aa), from the results of a borehole roughly centrally positioned on Lot 3044 and drilled to a depth of about 6 m, Residential Engineering reported that natural soil was not encountered. This indicates that fill more than 6 m deep was confirmed at the site.

83. Reference (m) indicates that the depth of fill at Lot 3044 can be as deep as 6.5 m.

84. Within an area of about 4,400 m^2 bounded by the dashed line and approximately centred by Lot 3044 as shown in Figure 11, we have determined from Reference (m), the compaction test result at every location tested.

85. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined. A total of 34 tests was carried out, which were all examined.

86. The results are shown in Figure 12 as a graph of density ratio with RL.

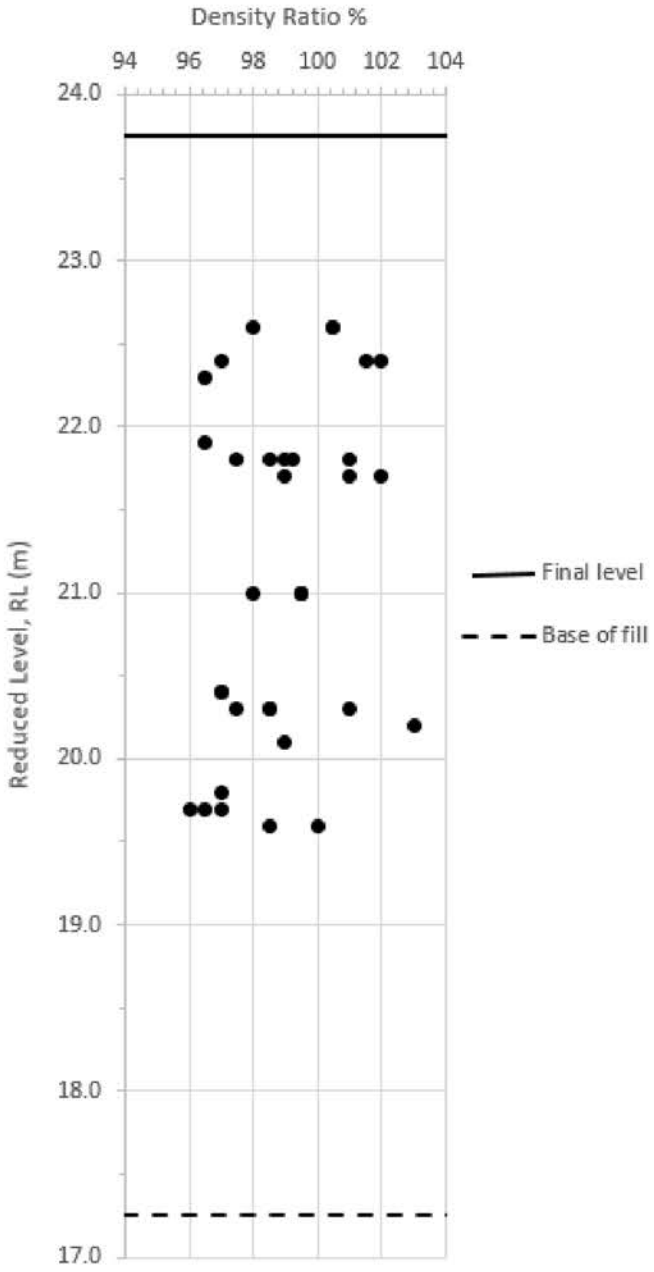

Figure 12: Density Ratio vs RL for all tests within the vicinity of Lot 3044 (see Figure 11)

87. Several conclusions can be made from Figure 12 as follows:

- For up to 6.5 m depth of fill, and a ground surface of about RL 23.75 m, the base of the fill will be at about RL 17.25 m. No tests have been conducted in the lower 2.3 m of fill. By the Douglas Partners specification of 1 test per layer per 1500 m^2, for a compacted layer thickness of 250 mm, the number of tests required over the 4400 m^2 area for this lower 2.3 m depth of fill is (4400/1500) x (2300/250) ≈ 27, rather than no tests,
- No tests are reported for the upper 1.0 m thickness of the fill, and
- The lift thickness appears to exceed 500 mm in parts, which is greater than that specified.

88. It is concluded from Figure 12 that the earthworks, at least in parts of the area of Lot 3044, had insufficient control during construction, so that the quality of the fill, in parts, is uncertain.

Lot 3032 (No. 1) Poynting Street

89. Lot 3032 is located within Stage EW6.2, as shown in Figure 13. Figure 13 also shows the locations of compaction tests (from Reference m) in the vicinity of Lot 3032.

90. In Reference (bb), PSM have indicated that the site contains about 4 m depth of fill. This depth of fill is consistent with that indicated in Reference (m).

91. It is understood from Reference (m), that the final ground surface at Lot 3032 is about RL 22.2 m.

92. Within an area of about 6,000 m^2, approximately centred by Lot 3032 as shown in Figure 13, the writers have determined from Reference (m), the compaction test result at every location tested.

93. For each test location, the value of measured density ratio and the Reduced Level (RL) of the test were determined. A total of 39 tests was carried out, which were all examined.

94. The results are shown in Figure 14 as a graph of density ratio with RL.

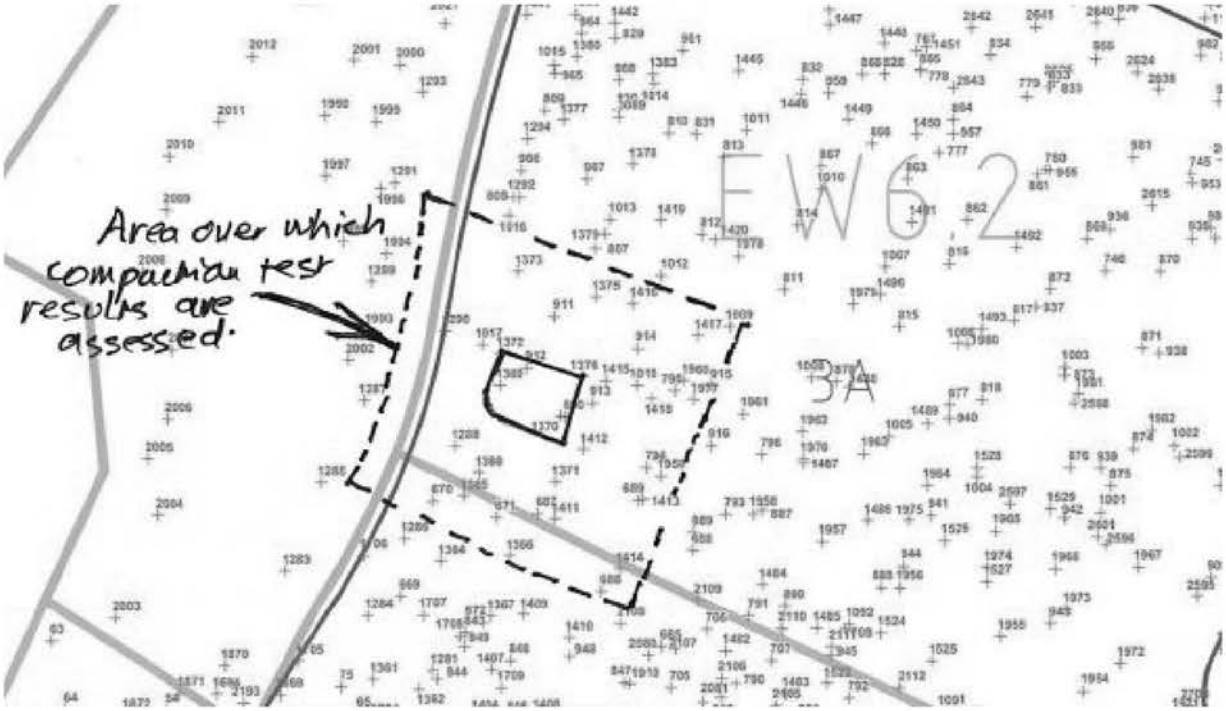

Figure 13: Area within Stage EW 6.2, and approximately centred by Lot 3032 where compaction test results were examined

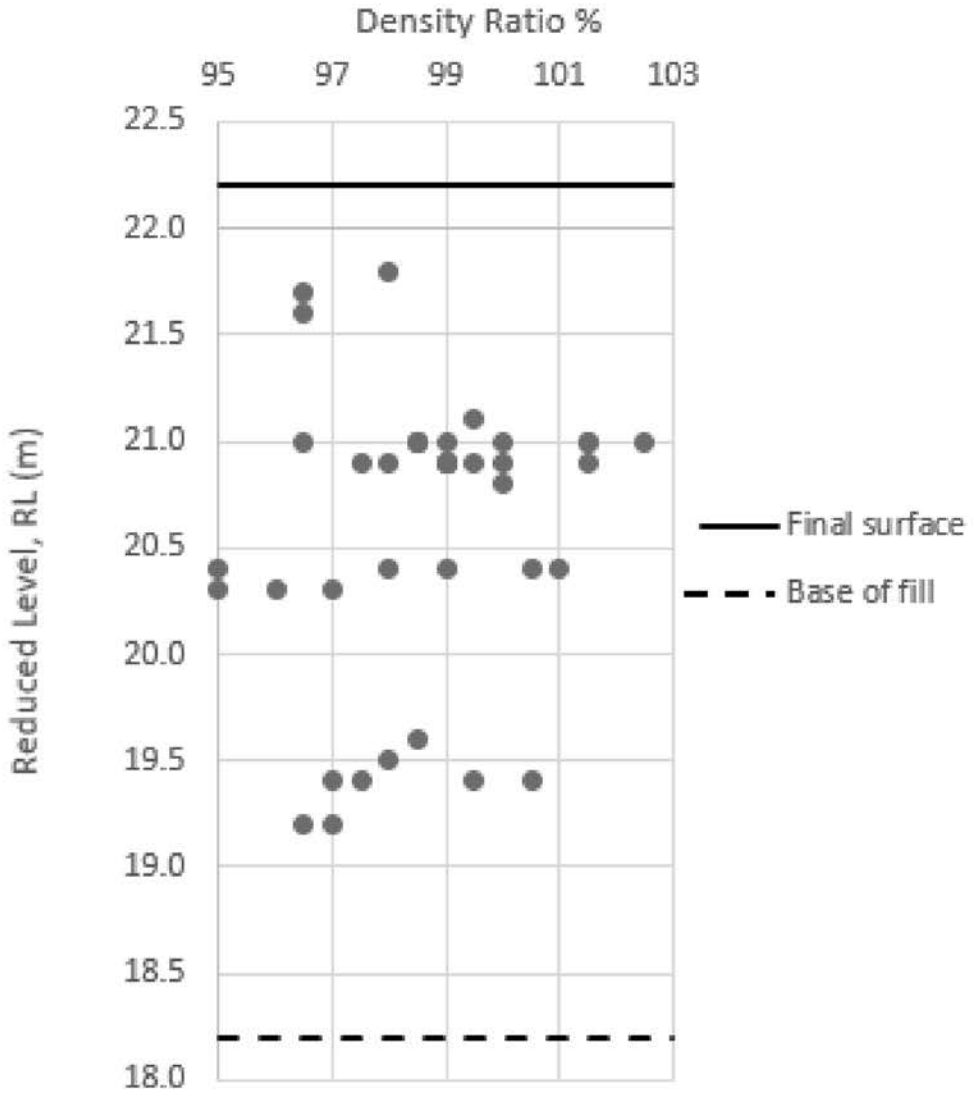

Figure 14: Density Ratio vs RL for all tests within area shown in Figure 13

95. Several conclusions are made from Figure 14 as follows:

- For a 4 m depth of fill and the ground surface at RL 22.2 m, the base of the fill will be at about RL 18.2 m. No tests have been conducted in the lower 1 m of fill. By the Douglas Partners specification of 1 test per layer per 1500 m^2, for a compacted layer thickness of 250 mm, the number of tests required over the 6,000 m^2 area for this lower 1 m depth of fill is (6000/1500) x (1000/250) =16 tests rather than no tests, and
- No tests are reported for the approximate 700 mm thickness of fill from about RL 19.6 m to about RL 20.3 m. By the Douglas Partners specification of 1 test per layer per 1500 m^2 and a compacted layer thickness of 250 mm, the number of tests required over the 6,000 m^2 area for this lower 700 mm depth of fill is (6000/1500) x (700/250) ≈ 11 tests rather than no tests.

96. It is concluded from Figure 14 that the earthworks, at least in parts of the area of Lot 3044, had testing not meeting the requirements of the earthwork's specification, and so the earthworks, in sections, had insufficient control during construction, so that the quality of the fill, in parts, is uncertain.

Lot classification certificates of sites by PSM

97. In the lot classification certificates provided by PSM for JSE seen by the writers, such as References (y), (bb), (cc), (dd), and (ee), PSM state that "*The CPT data indicates that fill of low relative compaction may exist beneath the allotment*".

98. This therefore means that the filling was not adequately controlled at the time of placement, and that minimum compaction level may not have been achieved in parts of the fill platform. This renders the compacted fill beneath the allotment uncontrolled.

99. In Reference (b), PSM have claimed that by carrying out CPTs on the fill well after placement, and by making a prediction of the collapse settlement, that this changes the fill from uncontrolled fill to controlled fill.

100. The writers disagree with this approach by PSM because, as outlined in Paragraph 10, AS2870-2011 clause 1.8.13 defines controlled fill as:

> *Fill that will be required to support structures or associated pavements, or for which engineering properties are to be controlled.*

101. The key phrase here is '*for which engineering properties are to be controlled*'. Control measures include the type of fill, the compaction density and moisture content, and lift thickness.

102. This control is carried out during construction of the fill by full-time on-site supervision by competent personnel, checking and testing of the placement of the earthworks: the construction of the fill is controlled, hence the term 'controlled fill'.

103. A fill that did not have this control during construction, is called 'uncontrolled fill'.

104. Determining the properties of uncontrolled fill several years after placement, will not render the fill as controlled fill.

Conclusion

105. At Jordan Springs East, there is evidence of end-tipped fill with little or no compaction and open voids; fill that has received little or no moisture conditioning and does not conform to the minimum moisture content requirements; the presence of unsuitable material such as concrete, wood, organic matter, and boulders; non-homogeneous material, including layers of fill material differing substantially from surrounding material and marked density variation within each compacted layer.

106. We have identified and analysed many instances where significant departures from the testing requirements of the earthwork's specifications have occurred at JSE. These are related to the loose layer thickness in many locations exceeding the 300 mm maximum specified, no confirmatory testing conducted to verify minimum compaction criteria throughout the full depth of the layer if the layer thickness exceeded 300 mm loose thickness, and the frequency of testing being less than the minimum requirements. These departures from the project earthwork's specifications mean that sections of the fill at JSE contain uncontrolled earthworks.

107. We have found that parts of the fill platform, including within and outside the ARAA, indicate that:
    a) there are significant departures from the requirements of the earthwork's specifications for the site,
    b) the Level 1 Control provided by Douglas Partners at Jordan Springs East cannot be relied upon, and
    c) sections of the fill platform at Jordan Springs East contain uncontrolled earthworks.

Statement

108. We have made all enquiries that we believe are desirable and appropriate and no matters of significance which we regard as relevant have, to our knowledge, been withheld.

Yours faithfully

Professor Nasser Khalili

Dr Peter W Mitchell
Geotechnical Consultant