Appendix 3
Anticipated Extraction Sequence

(No. of pages excluding this page = 10)

This page has intentionally been left blank

Introduction

Figures 2.4 to **2.6** (of the main *Environmental Assessment* report) present the anticipated development and extraction sequence for Stages 3, 4 and 5. Information on the probable destination and use of soil and overburden material, destination of silt generated by the sand washing, construction of Project Site infrastructure and progressive rehabilitation is also illustrated. It is noted that the proposed extraction sequence is indicative and may be subject to change over the life of the quarry. For example, it may be necessary to locally modify the sequence of extraction or area of various stages to ensure suitable capacity for the deposition of silt is maintained.

The following provides further detail of the proposed development and management of Stages 3, 4 and 5.

Stage 3 Extraction Sequence

Figure 2.4 presents the current extraction sequence for Stage 3 of the quarry. Notably, the acoustic bund wall has been constructed around the perimeter of Stage 3, extraction from Stage 3/1 has been completed and extraction is currently being undertaken in Stage 3/2. The following text provides a description of current and proposed activities. In any instances where this sequence, area of extraction or placement of structures or material needs to be modified, it would be identified and described in either the relevant Annual Environmental Report or future five-yearly updates of the Environmental Management Plan for the Calga Sand Quarry.

Stage 3/2

Water from Dam 6 has been drained with extraction activities effectively a westerly extension of the Stage 3/1 extraction area. This stage has been divided roughly in half in a north-south direction with extraction currently being undertaken in Stage 3/2a (closest to Stage 3/1). Silt is currently being deposited within Silt Cell 2c. To maximise the capacity of silt storage within Silt Cell 2c, the effective depth of the cell would be raised by approximately 4m. This elevation of the silt cell is referred to as Silt Cell 2c(ii).

As extraction activities reach their conclusion within Stage 3/2, Rocla intends to construct a second wash plant on a prepared site on the capped and stabilised Silt Cells C3b and C4 (Site B).

Stage 3/3a

Stage 3/3a represents the approved area of extraction at the southeastern limit of Stage 3. In order to extract the sand resource from Stage 3/3a, the silt and capping material currently stored in Dams 10, 11 and 12 would be dredged or excavated and removed. Any consolidated material would be used in the same manner as overburden, clay or oversize is currently, ie. as a capping material for the completed silt cells (Silt Cell 2c).

Once the consolidated silt and capping material is removed, extraction of the remaining sand resource would progress in a west to east direction. Whilst extraction is undertaken within Stage 3/3, the processing equipment (ie. the mortar sand plant and wash plant) of Site A would be relocated to the prepared site of Stage 4/2a (Site C). Stage 3/3 would also involve the relocation of the administration and workshop areas to the southeastern corner of the Project Site along with the relocation of the site access route. The layout of the administration area, workshop and mobile plant lay-down are further discussed in Section 2.8.

Silt generated by the washing of the sand from Stage 3/3a would be deposited within Stage 3/1, as well as within silt cells constructed on the completed sections of Stage 3/2.

Given the majority of the Stage 1 to 3 quarry area would remain active at this time in the extraction sequence, rehabilitation would be limited to the revegetation of completed benches within Stages 3/1 and 3/2, along with opportunistic revegetation of areas surrounding Dams 7a and 7b/c not required for ongoing activities such as sand processing or stockpiling.

Stage 3/3b

Stage 3/3b represents a southerly extension of Stage 3/3a which would effectively join the Stage 3 and 4 extraction areas. Stage 3/3b would extend approximately 30m onto Lot 1, DP 805358, allowing for a ramp from the floor of the extraction area to surface to be constructed. This ramp would provide both the new access road to the Stage 3 Quarry, identified as Access Route 2 on **Figure 2.4**, as well as a separate access road for the Stage 4 operations from the southern entrance which would have been constructed by this time.

Silt generated by the washing of the sand from Stage 3/3b would be deposited within silt cells constructed within Stage 3/1, Stage 3/2 and Stage 3/3a.

Stage 3/4

Extension of extraction operations into this stage will require the demolition and removal of the existing residence and associated buildings in that area of the Project Site. While Rocla intends to maintain the extraction sequence proposed, some flexibility may need to be incorporated into this sequence. The owner of the residence located on Stage 3/4 may wish to remain for an additional period of time and this being the case, Rocla will begin extraction from Stage 3/5 in preference to Stage 3/4.

This will allow the vacation of the residence at the convenience of the owner with extraction returning to the proposed sequence at that time. Any variation to the extraction sequence such as this will be incorporated into the relevant Annual Environmental Report.

Silt generated by the washing of sand from Stage 3/4 would be deposited within Stage 3/3.

During extraction from Stage 3/4 it is expected that those silt cells within Stages 3/1 and 3/2 would be capped and progressively stabilised. These completed and stabilised sections of the quarry would be progressively profiled to create the proposed final landform of the Project Site. Section 2.13.3 and **Figure 2.13** describe the proposed final landform to be created and Section 2.13.5 describes the proposed method of rehabilitation to be implemented.

Stage 3/5

This stage will essentially be a continuation of Stages 3/1 and 3/4 to the north. Silt generated by the washing of the sand from Stage 3/5 would be deposited in silt cells constructed within Stages 3/3, as well as within silt cells constructed on the completed sections of Stage 3/4.

Rehabilitation activities undertaken during Stage 3/5 would be a continuation of those undertaken as part of Stage 3/4, ie. capping, profiling and revegetation of the completed silt cells to construct the proposed final landform.

Stage 3/6

Stage 3/6 will be a continuation of extraction from Stage 3/3 to the north and 3/5 to the west. During this stage, silt would be deposited within Stage 3/4, as well as within silt cells constructed on the completed sections of Stage 3/5.

A small water storage dam (Dam 14) will be constructed within the northwestern section of Stage 3/6 as part of the final landform preparation. Dam 14 will act as a small water storage on Lot 2, DP 229889, replacing the dam removed by the extraction activities of Stage 3.

Stage 4 Extraction Sequence

Figure 2.5 presents the proposed extraction sequence for Stage 4.

Dam 16 (Sediment Basin 1)

Prior to any major surface disturbance within Stage 4, Rocla would construct Dam 16 ((Sediment Basin [SB] 1) immediately downstream of the lowest point of the Stage 4 extraction area (approximately 160m AHD). Access to Dam 16 would be via an internal access road constructed from Site A, and aligned to provide access to Stages 4/1, 4/2a and 4/3 as they are developed.

On construction, Dam 16 would function as a pollution control structure, with surface water flowing over areas to be disturbed as part of the development of Stage 4 (to the north of Creek A) diverted to this dam.

Based on the local soil types, SB1 would be constructed as a Type C sediment basin (in accordance with the recommendations of the guideline document "*Soils and Construction: Managing Urban Stormwater, Vol. 1, 4th eds.*", Landcom (2004)) with a capacity of at least 29m^3. The dam would be constructed by excavating down into the sandstone (rather than being built up from surface) and would remain unlined to allow for a constant seepage of water through the dam wall, which would contribute to base flows in Creek C and Cabbage Tree Creek downstream. The dimensions of the dam would allow for silt and clay which may accumulate within the dam, and inhibit seepage through the dam wall, to be excavated as required.

A discharge point, which would be rock-lined to reduce the potential for downstream erosion, would be constructed at the approximate location presented on **Figure 2.5**. Dam 16 would be retained for the life of Stage 4, with water which accumulates within the extraction area during heavy or prolonged rainfall transferred to this point either by gravity or pump.

The design and capacity of Dam 16 (SB1) is based on calculations of sediment storage and settlement zone requirements by Evans and Peck (2008) which is summarised in more detail in Section 5.2.5.

Stage 4/1

Following the construction of Dam 16, and associated drainage control (a diversion bank would be constructed upstream, diverting water into Creek A), Rocla would commence extraction activities within Stage 4/1, which has been designed to provide a buffer of at least 50m to Aboriginal site #45-3-2196, thereby minimising the risk of future accidental disturbance. Access to Stage 4/1 would be via an extension of the internal access road constructed from Processing Area Site A prior to the construction of Dam 16.

The objective of initial extraction activities would be to create storage areas for water and silt, such that Processing Area Site C may be established as quickly as possible, whilst minimising the volume of extracted sand which requires processing or stockpiling on Stage 3. To achieve this objective, Stage 4/1 would be developed as four smaller silt or water storage cells, identified as W1, S1, W2 and S2 (where **W** refers to water, **S** refers to silt and the number to the order of development, ie. W1 then S1, followed by S2 then W2[1]).

Topsoil and subsoil stripped from Stage 4/1 would be either directly transferred for silt cell capping or rehabilitation activities within Stage 3, or stockpiled within the Stage 1 for future use in this manner. Any overburden would either be used immediately to construct an acoustic bund wall around Stage 4/1, transported to Stage 3 for use in either silt cell construction or capping, or stockpiled for future use in site rehabilitation works within Stage 3.

Extraction would commence at the lower elevation (southwestern) perimeter of the extraction stage, with W1 then S1 developed in a northeasterly direction. The depth of friable sandstone with Stage 4/1 has been estimated to be 20m, although storage cell W1 would only be extracted to a depth of 10m to create an initial water storage. Rather than remove all the sandstone and then replace material to separate the four cells within Stage 4/1, the sandstone would be left in-situ (with a height of between 5m and 10m and width of approximately 5m) along the alignment of cell boundaries.

The sandstone extracted from cells W1 and S1 of Stage 4/1 would either be used to construct an acoustic bund around this and other extraction stages, or transferred to the processing area within Stage 3 (Processing Area Site A). The silt generated through the washing process would be pumped to active silt cells in Stage 3/1 (see **Figure 2.4**).

[1] Stages 4/2a and 4/3 would follow the completion of storage cells W1 and S1, at which time extraction of S2 and W2 would follow.

At the completion of cells W1 and S1, a diversion bank/channel would be constructed from Creek A to divert surface water into W1. This would ensure that a source of water would be immediately available for sand washing once the Site C processing area is established. Cell W1 would have an overflow/discharge point constructed at an elevation of between 160m and 165m AHD with water flowing from this point to Dam 16, and potentially onwards into Creek A.

Rehabilitation activities would involve the development of the final landform within Stage 4/1, and vegetation sowing and maintenance on this created slope (see **Figure 2.13**).

Stage 4/2a

Stage 4/2 has been split into 4/2a and 4/2b, as the stage would be initially excavated to an average depth of 10m below the natural land surface (Stage 2a) to provide a flat, acoustically shielded location for the construction of a wash plant and stockpile area (Site C). Stage 4/2b would involve the complete extraction (following Stage 4/3) to the maximum depth of extraction in that area following the relocation of the processing infrastructure to the floor of the completed Stage 4/3.

Access to Stage 4/2a would be via the same internal access road used to access Stage 4/1 and extraction would commence at approximately 180m AHD at the southwestern perimeter of the stage. The floor of Stage 4/2a would be maintained at approximately 180m AHD, with the depth below surface increasing to 20m at the northeastern corner of the stage.

The vegetation cleared, and topsoil and subsoil stripped in advance of extraction would be either directly transferred for rehabilitation activities, or stockpiled within Stage 3 for future use in this manner. Any overburden would either be transported to Stage 3 for use in either silt cell construction or capping, or stockpiled for future use in site rehabilitation works within Stage 3.

The sand and friable sandstone extracted from Stage 4/2a would be transported to the processing area of Site A (or possibly Processing Area Site B) and the silt generated through the washing process pumped to active silt cells in Stages 3/1 or 3/2 (see **Figure 2.4**). At the completion of extraction from Stage 4/2a, Rocla would commence the construction of a wash plant on the flat hardstand surface created.

Rehabilitation during this stage would involve the maintenance of the vegetation of the final landform within Stage 4/1.

Stage 4/3

This stage represents an extension of Stage 4/2 to the northeast, where it would be bounded to the north by a 3m wide access ramp which is identified on **Figures 2.3** and **2.4** as Stage 3 Access Route 2 and Stage 4 Northern Access Route respectively. Whilst extraction from Stage 4/3 is ongoing, Rocla would commence the construction of the proposed southern entrance to the Project Site. By the completion of Stage 4/3, this entrance would be linked to the processing area of Site D by the Stage 4 Northern Access Route.

As vegetation is cleared and soil stripped from this stage, it would be either transferred directly for silt cell capping and/or rehabilitation activities within completed sections of the Stage 3 or 4 quarry, or stockpiled within the Stage 3 for future use in this manner.

The depth of friable sandstone within Stage 4/3 has been estimated to be approximately 20m below surface, with two 10m benches created as the extraction area is developed. On completion of extraction from Stage 4/3, Rocla proposes to relocate all processing infrastructure and stockpiles to this location. In order to overcome the sloping nature of the final quarry floor, Rocla would use overburden removed as the stage is developed, and/or clay previously excavated from Stage 3/1 and currently stockpiled on Stage 3/5, to create a series of tiered flat areas over Stage 4/3.

Stage 4/3 would be developed concurrently with Stage 3/3 with the access ramp which bounds these two stages created as extraction progresses to the east in each stage. The ramp would be constructed with a constant gradient of 1:10 (10º), before reaching the surface and merging with the Stage 3 Access Route 2 constructed from the northern entrance to the Project Site and Stage 4 Northern Access Route constructed from the southern entrance.

The overburden removed from Stage 4/3 would be used as a fill material on the floor of the stage to create the tiered flat surfaces required for the relocated processing infrastructure. Any remaining overburden would be used to construct and/or cap silt cells within the Stage 4 quarry.

The sandstone extracted from Stage 4/3 would be processed through the wash plant and mortar sand plant of Processing Area Site C. Silt generated by the washing process would be deposited in cell 4/1-S1 or within Stage 3/2.

Rehabilitation during this stage would involve the maintenance of the vegetation of the final landform within Stage 4/1.

Dam 17

Prior to the completion of extraction from Stage 4/3, and prior to surface disturbance within Stage 4/4, Rocla would construct Dam 17 immediately downstream of the lowest point of the Stage 4/4 extraction stage (approximately 170m AHD). Similar to Dam 16, Dam 17 would function as a secondary control structure, with surface water flowing over areas to be disturbed as part of the continuing development of Stage 4 diverted to this dam. The dimensions of Dam 17 would be similar to those of Dam 16 and would be constructed by excavating down into the sandstone (rather than being built up from surface) to maintain base flows to Creek C and Cabbage Tree Creek downstream.

A discharge point from Dam 17 would be rock-lined to reduce the potential for downstream erosion, would be constructed at the approximate location presented on **Figure 2.5**. Dam 17 would be retained for the life of Stage 4, with water which accumulates within the extraction area during heavy or prolonged rainfall transferred to this point either by gravity or pump.

Stage 4/4

This stage represents an extension of Stage 4/1 to the east and Stage 4/2 to the south. Similar to Stage 4/1, this extraction stage would be developed as a series of four cells (W3 for water storage and S3 to S6 for silt storage). Cell W3 would have an overflow/discharge point constructed at an elevation of between 170m and 155m AHD with water flowing from this point to Dam 17, and potentially onwards into Creek A.

The overburden removed from Stage 4/4 would be used to construct and/or cap silt cells within the Stage 4 quarry.

The sandstone extracted from Stage 4/4 would be processed within Site D with silt deposited progressively in cells 4/1-S1, 4/1-S2 or 4/1-S3.

Rehabilitation activities would involve the sowing of vegetation on the terminal benches of Stage 4/2 and the maintenance of the vegetation of the final landform within Stage 4/1.

Stage 4/2b

Following the establishment of processing Site D within the completed Stage 4/3, the processing plant of Site C would be removed and the remaining friable sandstone from Stage 4/2 extracted to a maximum depth of between 20m and 30m below surface.

The friable sandstone would be transported to Site D for washing and dry screening, with the silt generated through the washing process pumped to active silt cells in Stages 4/4.

Rehabilitation during this stage would involve the maintenance of the vegetation within Stage 4/1 and 4/2.

Stages 4/5 and 4/6

Stage 4/5 would be an easterly extension of Stage 4/4, with Stage 4/6 then extending the extraction area to the northeast. The average depth of friable sandstone in these stages is estimated to be 30m.

Prior to any surface disturbance within these stages, a temporary water storage dam would be excavated within Creek A. These dams would prevent surface flows into the active extraction stages, as well as provide a supplementary source of water for sand washing. The dams would be constructed such that water can be pumped to the established water storages of W1 to W3, or allowed to overflow around the active stage (through construction of a diversion bank).

Extending from Stage 4/4 to the east, extraction from Stage 4/5 and 4/6 would be progressively developed with benches oriented generally parallel to the existing contours. Similar to previous extraction stages, extraction within Stage 4/5 would be undertaken as a series of extraction cells which would then be used for water or silt storage. Cell W4 would form the final water storage within Stage 4, with the remaining cells (S6 to S8) developed for silt deposition and consolidation. An overflow/discharge point would be constructed from Cell W4, with water then flowing to Dam 17 and eventually Creek B or C.

Topsoil and subsoil would be either directly transferred for spreading over capped silt cells and other rehabilitation activities, or stockpiled within the Stage 4/2 for future use in this manner. Overburden would be used in the construction of silt cells within Stage 4/5, and then Stage 4/6 once completed. Additional overburden not immediately required would stockpiled within Stage 4/2 for future use.

Sand washing, screening and blending activities would be undertaken within Site D with silt deposited in the silt cells of Stages 4/4 and 4/5.

Rehabilitation would include the creation of the final landform within Stages 4/4, 4/5 and 4/6, the revegetation, capping and soil application to completed silt cells in 4/1 and 4/4 (if complete) and the continuing maintenance of the revegetating terminal benches of Stages 4/1, 4/2 and 4/4.

Stages 4/7 and 4/8

These two stages represent the completion of extraction from Stage 4 and would be developed in much the same manner as Stages 4/4 to 4/6. The depth of friable sandstone in Stage 4/7 is estimated to vary between 20m and 30m, with 20m estimated as the average depth in Stage 4/8.

Topsoil and subsoil would be either directly transferred for spreading over capped silt cells and other rehabilitation activities, or stockpiled within the completed stages of Stage 4 for future use in this way. Overburden would be used in the construction of silt cells within Stages 4/4 to 4/6, or stockpiled for future silt cell construction or capping.

Friable sandstone would initially be transported to Site D for the Stage 4/1 processing area and the silt generated through the washing process pumped to active silt cells in Stages 4/5 and Stage 4/6.

Rehabilitation would include the creation of the final landform within 4/6 and 4/7, and capping and soil application to completed silt cells. The completed silt cells of Stage 4/5 and then 4/6 would be covered with available overburden and soil resources as part of the final landform construction. As silt generated by the washing of sand from Stage 5 would be deposited within the silt cells of Stage 4/6 and 4/7, complete landform profiling and rehabilitation would not be able to be completed until the completion of Stage 5.

Stage 5 Extraction Sequence

Figure 2.6 presents the proposed extraction sequence for Stage 5. This includes information on access, overburden placement and profiling and rehabilitation.

Dam 18 (Sediment Basin 2)

The first activity would involve the excavation of Dam 18 (Sediment Basin [SB] 2) at an elevation of approximately 170m AHD to the immediate southwest of Stage 5/1. As with Dam 16, this dam would function as a pollution control structure, accepting surface water flowing

over areas to be disturbed as part of the development of Stage 5. Based on the local soil types, SB2 would be constructed as a Type C sediment basin (in accordance with the recommendations of the guideline document "*Soils and Construction: Managing Urban Stormwater, Vol. 1, 4th eds.*", Landcom (2004)) with a capacity of at least 16m^3. As with Dams 16 and 17, Dam 18 would be constructed by excavating down into the sandstone (rather than being built up from surface) to maintain base flows in Creek C and Cabbage Tree Creek downstream.

A discharge point from Dam 18 would be rock-lined to reduce the potential for downstream erosion, would be constructed at the approximate location presented on **Figure 2.6**. Dam 18 would be retained for the life of Stage 5, with water which accumulates within the extraction area during heavy or prolonged rainfall transferred to this point either by gravity or pump.

The design and capacity of Dam 18 (SB2) is based on calculations of sediment storage and settlement zone requirements by Evans and Peck (2008) which is summarised in more detail in Section 5.2.5.

Stages 5/1 and 5/2

These two stages represent the initial areas of extraction within Stage 5 and would be developed in much the same manner as Stage 4/1, and 4/4 and 4/5 within Stage 4.

The depth of friable sandstone with Stage 5/1 and 5/2 would commence at approximately 8m, gradually increasing to 20m at the boundary of these stages with Stage 5/3 (see **Figure 2.3**). Extraction would be in a southeasterly direction, ie. perpendicular to the contour. Initial extraction would be as a single 8m to 10m bench, however, as the depth of friable sandstone increases above 10m, a second bench would be constructed. The floor of Stage 5 would slope to the northwest (similar to surface topography) with Dam 19 constructed at the southwestern corner of Stage 5/1 by excavating an additional 3m to 5m below the quarry floor. The size of Dam 19 would be gradually increased as extraction area increases. By increasing the size of Dam 19, the potential seepage from the dam back into the sandstone would be increased along with base flows to Creek C and Cabbage Tree Creek. Water accumulated in Dam 19 would be pumped as required into Dam 18 to ensure sufficient storage capacity is maintained for a heavy or prolonged rainfall event.

Topsoil and subsoil would be either directly transferred for spreading over capped silt cells and other rehabilitation activities in Stage 4, or stockpiled within Stage 5 for future rehabilitation activities. The overburden and clay/shale layers excavated would be used in the construction of an acoustic bund around the active extraction stage or replaced on the completed floor of Stage 5 as part of final landform construction.

Friable sandstone extracted from Stage 5/1 would be transported to the processing plant of Site D via the Stage 5 Access Road, an internal haul road constructed predominantly along the southern edge of a cleared power line easement. Where Stage 4/8 crosses this easement, the haul road would be constructed around the perimeter of Stage 4/8 before joining the access road to Stage 4 ("the Stage 4 Access Road"). The silt generated through the washing process would be pumped to active silt cells in Stage 4/5 to 4/7.

Rehabilitation would include final landform profiling, soil application and revegetation of the created landform within Stage 5. Silt cell capping and profiling within the Stage 4 would be undertaken at this time as well. Overburden would be sourced from the now redundant acoustic bund wall around Stages 4/7 and 4/8, supplemented by oversize material generated by the processing plant.

Stage 5/3

Stage 5/3 represents the final area of Stage 5 with the depth of friable sandstone estimated to remain a consistent 20m below surface over the stage (see **Figure 2.3**). Given the increased depth of sandstone, Stage 5/3 would be developed in a southeasterly direction with two active 10m benches. Otherwise, development would be in a similar manner to that of to Stages 5/1 and 5/2, ie. up-slope development with all water runoff directed to Dam 19.

Overburden would be used to construct the acoustic bund wall around the stage with topsoil and subsoil material either directly transferred to ongoing rehabilitation works in Stage 4, or immediately transferred or stockpiled within Stage 5 for use in rehabilitation.

Friable sandstone extracted from Stage 5/3 would be transported to the processing plant within Site D via the Stage 5 Access Road. Silt generated by the washing of the sand extracted from Stage 5/3 would be pumped to active silt cells in Stage 4/7.

Rehabilitation activities would include ongoing works in Stage 4 and vegetation of the final landform within Stage 5/3.