Dry Creek Salt Field Section 1 – Salt Residues Disposal

Trial Plan

Buckland Dry Creek Pty Ltd

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Tonkin CONSULTING

a better approach

Document History and Status

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1 Overview of Proposal

This Salt Residues Disposal Trial Plan (the Trial Plan) describes methods being considered for the future rehabilitation of salt crystalliser pans once commercial salt production ceases in Section 1 at the Dry Creek Saltfields (the site).

The Trial Plan describes the operations and procedures that Buckland Dry Creek Pty Ltd propose to develop, in a progressive manner, to achieve the predicted outcomes discussed in the Program for Environment Protection and Rehabilitation (PEPR) and Mine Operations Plan (MOP), for Section 1 of the Dry Creek Saltfields (Figure 1.1).

Figure 1.1 Dry Creek Salt Fields showing F Row and G crystalliser Rows, final area and bitterns discharge points and brine storage pits located at the north of the crystalliser pans. Image source: MetroMap.

1.1 Background

To facilitate the future remediation of Section 1, Buckland Dry Creek Pty Ltd proposes undertake a trial that removes residual salt and saline soil from the surface of crystalliser pans and uses the material to fill and rehabilitate two existing voids (pits) that have historically been used to store surplus brine and bitterns.

The predicted outcome of the rehabilitation trial is to facilitate the future use of the majority of the site for mixed urban development, facilitate the construction of the Northern Connector and improve management of stormwater flows in Dry Creek.

Removal of the residual salt and associated saline soils from the Section 1 crystallisers is proposed to be undertaken in the following ways:

1. Recovery and washing of commercially useable salt, followed by its transport offsite
2. Disposal of unusable salt and saline soil into the existing voids (pits)
3. Disposal of brines by controlled pumping into the Port River

The first of these methods is underway. The plan described in this report covers a trial of the second method. The third method is the subject of a separate application for regulatory approval.

The Trial Plan is required to manage an estimated 275 – 425 MT of salt and saline soil that will not be able to be processed for commercial sale or disposed of as brine, as currently undertaken under licence. This salt may be left *in situ*; however it is considered that this will increase potential risks to future development and the environment. In addition, the two voids located in the northern portion of Section 1 will require filling prior to future development of the site. The two voids, the F Row and G Row Pits, are currently used for holding excess brine (NaCl) or MagBrine (magnesium-rich brine) and have a combined void volume of over 450,000 m^3.

The Trial Plan described in this report seeks to maximise the effective use of waste salt and soil, develop and monitor the operational performance of the trial disposal methods, develop and implement a monitoring framework to improve the understanding of existing conditions and monitor the impacts on the environment, and to further investigate salt management requirements and alternative land and non-land based disposal options.

1.2 Proposed Rehabilitation Strategy for Section 1

The ultimate aim of rehabilitation for Section 1 is to create a finished landscape suitable for residential development, including vegetated open space areas, and/or stormwater management. The proposed rehabilitation strategy includes the removal of waste salt and a small amount of the underlying soil from the crystallisers and placement of the waste material into the F Row and G Row Pits. Once the waste salt/soil material is placed, it is proposed to cap the filled Pits with clean fill and vegetate using endemic species. The location of the site is presented in Figure 1.2, along with a conceptual cross-section that illustrates the rehabilitation outcomes proposed.

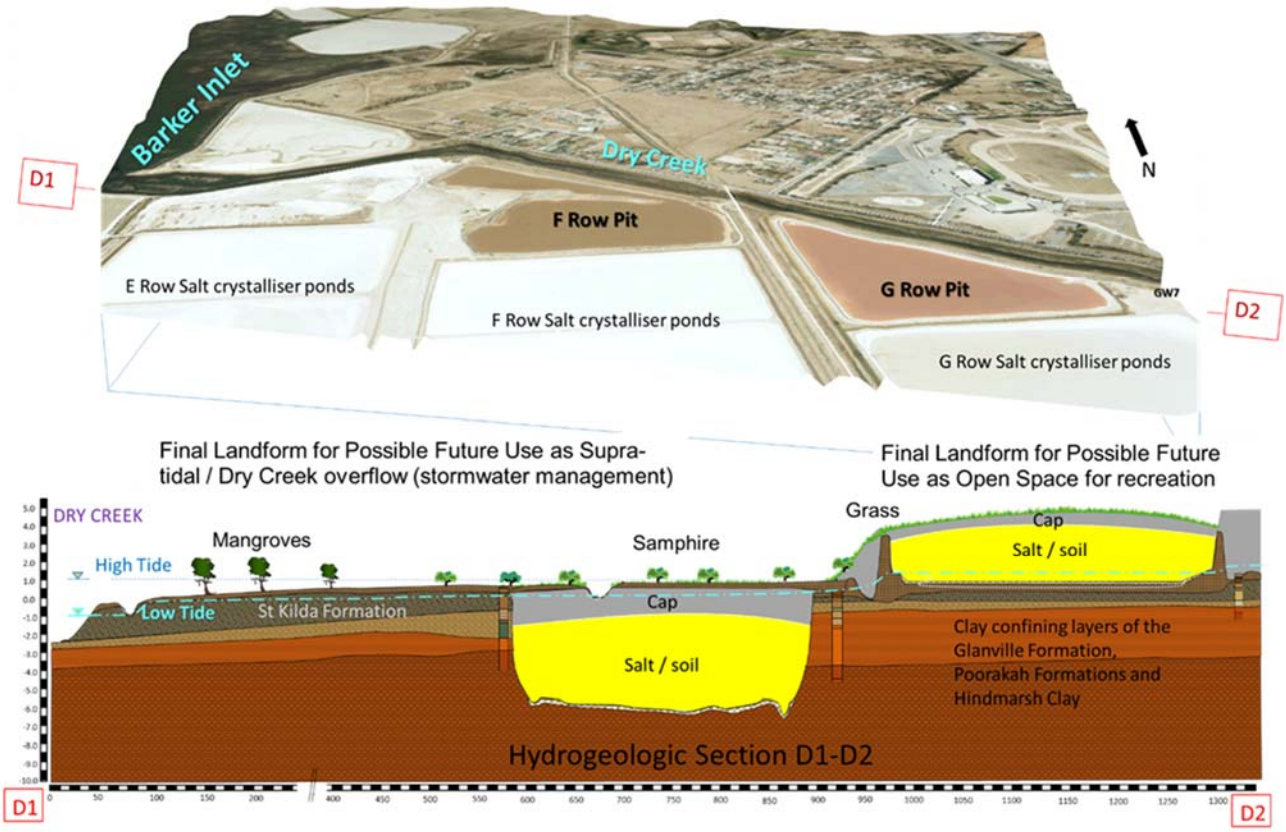

Figure 1.2 Site Location and Features and Concept Sketch that illustrates the rehabilitation outcomes proposed

The proposed rehabilitation strategy involves:

1. the removal of waste salt and a small amount of the underlying soil from the crystallisers, as addressed by the existing MOP/PEPR;
2. trial placement the waste salt and material into the F Row and G Row Pits and capping, which is the subject of this plan
3. preparation of the new PEPR/MOP for rehabilitation for Section 1. This plan will cover the final landform design, site use, landscaping, stormwater management, operation and maintenance requirements (including on-going monitoring as required).

The trials proposed herein are required to demonstrate that the proposed rehabilitation strategy can achieve the rehabilitation aim and can be managed in a way that does not create additional risks, nor increase the existing risk profile of the site. It is proposed to undertake a staged program of investigations and field scale trials allowing for review and hold points through the trials. The objectives of the staged trials are to:

- investigate the feasibility of the rehabilitation strategy;
- identify any potential impacts to environmental receptors;
- develop and test management and contingency measures designed to minimise the likelihood and consequence of an unacceptable impact on the environment;
- develop a monitoring and management plan required to assess the effectiveness of the rehabilitation strategy;
- identify the sources of issues to meeting rehabilitation and closure objectives;
- inform the development of Rehabilitation Plan for Section 1.

1.3 Legislative Requirements

The *Mining Act 1971* is the principal legislation regulating the operation and closure of the Buckland Dry Creek Pty Ltd Creek Salt Field. Under associated regulation, a Program for Environment Protection and Rehabilitation (PEPR) and Mine Operations Plan (MOP) for the Dry Creek Salt Fields has been prepared which sets out operations to be undertaken by Buckland Dry Creek Pty Ltd during the closure of the site and provides a basis for government to approve the works to be implemented. The Environmental Outcomes and Measurement Criteria from the PEPR/MOP are discussed in detail in Section 5.

The Dry Creek Salt Field is also classified as an activity of environmental significance and hence requires licencing under the *Environment Protection Act 1993*. The current licence conditions are predominantly concerned with the discharge of saline water into coastal waters of the Barker Inlet and a limitation on salinity of 45 parts per thousand has been imposed.

1.3.1 Commitment to the Approved PEPR

The plan for these monitored trials is to be incorporated into a revision of the current PEPR/MOP for the residual operations and holding pattern at the Dry Creek Salt Field, for Department of State Development (DSD) approval. The DSD will be kept informed of progress and outcomes of the approved program during the operational period.

Once sufficient data are available from the initial stages of the monitored trial, the plan for the permanent disposal of the solid salt residues will be developed and incorporated into a future revision of the PEPR/MOP that regulates the rehabilitation and closure of Section 1 of the Dry Creek Salt Field and submitted for DSD approval.

1.4 Consultation with Stakeholders

There have already been preliminary consultations with Salisbury Council and the STAG (Strategic and Technical Advisory Group) on the proposed permanent disposal of the solid salt residues in the Pits and the integration of the final landform with the Dry Creek corridor. These stakeholders have expressed in principle support, subject to

1. satisfactory outcomes of the trial; and
2. satisfactory planning and design of the final landform.

Consultations with DSD and South Australian Environmental Protection Authority (SA EPA) on the proposed trial and longer-term plans for the site have also been undertaken. The purpose of these consultations was to discuss trials which would be used to obtain evidence to facilitate the approval for the permanent disposal of the solid salt residues in these pits and the integration of the final landform with the Dry Creek corridor. These consultations have led to this revised report.

Key stakeholders will be further consulted to obtain and take into account their views about the use of F and G Row pits for the permanent disposal of the solid salt residues and about the proposed final landform and land uses. These stakeholders include, but may not be limited to:

- DSD, SA EPA
- Salisbury Council
- Department of Planning, Transport and Infrastructure (DPTI)
- Renewal SA
- Neighbouring landowners

1.5 Target Outcomes from Salt Disposal into F and G Row Pits

The target end result from the disposal of residual salt into F and G Row Pits is to create a landform that:

- enables its future use as passive open space;
- improves the functioning of the Dry Creek drainage corridor;
- has acceptable levels of impact on the environment over the short and long term.

Field-scale trials are proposed to ensure that the levels of impact are understood. On successful completion of the trials, Environmental Outcomes and Measurement Criteria for the long term disposal of salt into F and G Row Pits will be developed and embodied in a PEPR/MOP to be approved by Department of Sustainable Development (DSD). This PEPR/ MoP will be needed to close and surrender the parts of the mine tenements that F and G row pits occupy.

The proposed target outcomes of the salt disposal are:

- End results are acceptable for the defined future land uses. This will require:
  - Measurement criteria to include completion of a Site Contamination Assessment Report (SCAR) by an EPA-accredited Auditor on the suitability of the site for residential development;
  - The design and construction of the landform over F and G Row Pits and its landscaping being acceptable to the relevant planning authority under the Development Act.
- Intertidal receiving environment is protected. This will require that the quality of surface water or groundwater discharging to surface waters from these Pits must not detrimentally impact the receiving environment.
- The final landform is stable. This will require:
  - the settlement of the constructed landform over the capped and filled pits will need to be acceptably minor both in quantity and rate; and
- erosion of the landform being prevented by appropriate drainage and earthworks engineering and by vegetation.
- The biodiversity and aesthetics of the adjacent site as well as the constructed landscape is enhanced and conserved. This will require:
  - the constructed and adjacent landscape being protected from undue erosion or sediment deposition from stream flows; and
  - the landscape at the F Row Pit be returned to natural vegetation indigenous to the supra-tidal environment that existed prior to commencement of salt harvesting in Section 1; and
  - the G Row Pit be revegetated with native vegetation to provide an accession area for samphire vegetation and to serve as a buffer zone to adjacent residential land use.

1.6 Required Environmental Outcomes for the Conduct of the Trial

The required Environmental Outcomes and Measurement Criteria for the current approved PEPR / MoP are shown in Table 1.1. The relevance and applicability of these Outcomes and Criteria for the conduct of the Trials in F and G Row Pits have been included in the table. No additional Outcomes are required; however additional Measurement Criteria are necessary for water bores and have been proposed in Table 1.1.

Table 1.1 Environmental Outcomes and Measurement Criteria from PEPR/MOP (Table 30) and Relevance to Trial in F and G Row Pits

Outcome	Outcome Measurement Criteria (OMC)	Relevance to the Trial Filling F and G Row Pits
No adverse public health and/ or significant nuisance impacts due to air emissions, dust, pest insect species, odour, or noise (A significant nuisance impact is considered to be one that generates a complaint that is confirmed as attributable to the salt field and cannot be addressed within the timeframes specified in the measurement criteria.)	**Dust:** Register demonstrates that in respect of complaints relating to impacts from dust outside site boundary: • complaint initially responded to within 48 hours; • issues underlying complaint investigated and causes identified within 2 weeks or other time frame agreed by DSD; • complaint closed out within 4 weeks or other time frame agreed by DSD **Pest Insects:** Register demonstrates that in respect of complaints relating to impacts outside site boundary from pests: • complaint initially responded to within 48 hours; • issues underlying complaint investigated and causes identified within 2 weeks or other time frame agreed by DSD; • complaint closed out within 4 weeks or other time frame agreed by DSD **Odour:** Register demonstrates that in respect of any complaints relating to impacts outside site boundary from pests: • Complaint initially responded to within 48 hours; • Issues underlying complaint investigated and causes identified within 2 weeks or other time frame • agreed by DSD; • Complaint closed out within 4 weeks or such other time frame agreed by DSD **Noise** Register demonstrates that in respect of any complaints relating to impacts from noise outside the site boundary: • complaint initially responded to within 48 hours; • issues underlying complaint investigated and causes identified within 2 weeks or other time frame agreed by DSD; • complaint closed out within 4 weeks or other time frame agreed by DSD	Outcome is relevant and applicable Measurement Criteria for Dust, Pest, Insects, Odour, and Noise are relevant and applicable
No adverse impacts to adjacent land use	**Inundated ponds** Records from weekly monitoring of pond water levels demonstrate pumped entrainment and discharge have maintained water levels in ponds within target range set out in Table 31, or other levels agreed with EPA in writing. **Other ponds** Records demonstrate: • ASS / MBO investigations undertaken and results provided to EPA/DSD • risk monitoring and management plan prepared as agreed with DSD/EPA • actions in risk monitoring and management plan implemented in accordance with timeframes specified in plan • outcome measurement criteria specified in plan met **Bund banks** Records demonstrate that: • inspections every six months of bunds banks for inundated ponds demonstrate are stable and maintained at a height that will ensure no unplanned overflow from ponds; or • if any maintenance / repairs issues are identified from six monthly inspections, they are closed off within 1 calendar month unless otherwise agreed with DSD and EPA **Seepage Drains** Records demonstrate that: quarterly inspections of seepage drains demonstrate they are stable; or if any maintenance / repairs issues identified from quarterly inspections of seepage drains are closed off within 1 calendar month unless otherwise agreed with DSD and EPA	Outcome is relevant and applicable Measurement Criteria for Inundated ponds are not relevant Other ponds are considered to include F and G Row Pits for the purposes of the trial and hence measurement criteria are relevant and applicable Bund banks include F and G Row Pits for the purposes of the trial and hence measurement criteria are relevant and applicable Seepage Drains include F and G Row Pits for the purposes of the trial and hence measurement criteria are relevant and applicable

<table>
<tr><th>Outcome</th><th>Outcome
Measurement Criteria (OMC)</th><th>Relevance to the Trial Filling F and G Row Pits</th></tr>
<tr><td>No adverse impacts on other groundwater users</td><td>Water bores
Records of meter readings demonstrate the volume of water extracted per annum does not exceed the following allocations:
<table>
<tr><th>Bore Number</th><th>Aquifer</th><th>Allocation (kL)</th></tr>
<tr><td>6628_19184</td><td>T1</td><td rowspan="4">1,177,255</td></tr>
<tr><td>6628_10427</td><td>T1</td></tr>
<tr><td>6628_04356</td><td>T1</td></tr>
<tr><td>6628_13020</td><td>T1</td></tr>
<tr><td>6628_13170</td><td>T1</td><td rowspan="2">850,255</td></tr>
<tr><td>6628_18042</td><td>T1</td></tr>
<tr><td>6628_2005</td><td>T3</td><td>1,200,000</td></tr>
</table></td><td>Outcome is relevant and applicable
Measurement Criteria for Water Bores are not relevant
The following coupled Measurement Criteria are proposed:
• Salinity monitoring during outgoing tides in Dry Creek upstream and downstream of the likely field of discharge into the Creek from F and G Row pits shows no or negligibly small gain in salinity upstream to downstream (from baseline); and
• Monitoring of salinity in groundwater wells around F and G Row pits shows stable attenuation of concentrations with increasing distance away from the pits</td></tr>
<tr><td>No loss of abundance or diversity of native vegetation on or off Sections 2 to 4 of salt field through clearance arising from Holding Pattern, unless prior approval under relevant legislation is obtained</td><td>Records demonstrate that all clearance of native vegetation has been undertaken with appropriate permissions.
It is noted that clearance can also include loss from:
• physical works,
• dust/contaminant deposition,
• fire, or
• other damage.</td><td>Outcome is not relevant, as the Trials will be in Section 1, not Sections 2 to 4</td></tr>
<tr><td>No adverse impacts on the environmental values of marine waters due to water discharge</td><td>Records demonstrate that salinity from:
• PA5 discharges, measured at the "SA Water Outfall compliance point" taken no less frequently than each 10 minutes is within the 45ppt TDS threshold for the 6 hour rolling average.
• XE6 discharges, measured at the "Gawler River Discharge compliance point" taken no less frequently than each 5 minutes is within criterion for this compliance point -being the greater of:
- the maximum diurnal TDS measured in the past 30 days at the compliance point in the absence of discharge from XE6; or
- the measured contemporaneous maximum diurnal TDS in Chapman Creek (at the pumping station).
In the event of an exceedance at a discharge compliance point, records will demonstrate that:
• there has been notification to DSD, PIRSA and EPA within 24 hrs exceedance was followed by a period of nil discharge from PA5 or XE6, as appropriate, unless and until further discharge is approved by EPA Exceedance reports were provided within 3 days with root cause assessment and proposed or taken corrective action.</td><td>Outcome is not relevant as there will be no water discharge to surface waters from F and G Row pits. Also the measurement criteria for “No adverse impacts on other groundwater users” protects the environmental values of marine waters</td></tr>
<tr><td>No adverse impacts to avifauna using the site beyond internationally recognised impact thresholds, or outside historic ranges of variability in species and bird numbers</td><td>Records demonstrate that impacts on listed migratory birds from activities in this PEPR / MOP are below significant impact threshold as determined by EPBC Act significant impact guidelines for Matters of National Environmental Significance.
Inundated ponds
Records from weekly monitoring of pond water levels demonstrate pumped entrainment and discharge have maintained water levels in ponds within target range set out in Table 31, or other levels agreed with EPA in writing</td><td>Outcome is not relevant as Section 1 has not been and is not used significantly by avifauna</td></tr>
<tr><td>No compromise to potential future land use</td><td>Compliance with measurement criteria (as above) for the following outcomes:
• No adverse impacts to adjacent land use
• No adverse impacts to avifauna using the site beyond internationally recognised impact thresholds, or outside historic ranges of variability in species and bird numbers</td><td>Outcome is relevant and applicable
The measurement criteria for the following outcomes are relevant and applicable:
• No adverse impacts to adjacent land use
• No adverse impacts on other groundwater users</td></tr>
<tr><td colspan="3">NOTES:
Inundated ponds are defined as: Ponds XE1-3, XE5, XE6, XE7, XD1, XC3, XB3, XB4-5, XB6, XB8, XB8A, XA1, XA2, XA3, XA4, XA7, PA3, PA4, PA5
Other ponds are defined as XF1, XF2, XE4, XC1, XC2, XC2S, PA6, PA7, PA7A, PA8, PA9, PA10, PA11, PA12
The current approved PEPR is Dry Creek Salt Field PEPR October 2015.pdf; Approved 23 October 2015</td></tr>
</table>

1.7 Staged, Risk- Based, Adaptive Approach for the Trial

The Trial Plan adopts a staged, risk based approach, with each subsequent stage being dependent on the outcome of preceding investigations. This staged approach is designed to identify issues so they can be managed by adapting the design and conduct of the trial and enable feedback from stakeholders. The proposed stages are:

Stage 1	Preliminary Laboratory and Field Characterisation of Salt/Soil (and reporting)
Stage 2	Phase 1 (Filling) of Field Trial in G Row Pit (and reporting)
Stage 3	PEPR / MOP Revision for Phase 2 (Capping) of G Row Pit Trial and for F Row Pit Trial
Stage 4	Phase 2 of G Row Pit Trial and for F Row Pit Trial (and reporting)
Stage 5	Preparation of Revised PEPR / MOPs for the Long Term Disposal of Salt into F and G Row Pits, and the “Mine Closure” of these Pits.

The objectives and anticipated outcomes / information for each Stage are summarised in Table 1.2. Between each of these Stages are “hold points” with triggers that:

- Require Either adaptation of the design or scope of the next Stage; or
- Prevent the next Stage from proceeding.

The purpose of these “hold points” is to enable both DSD and Buckland Dry Creek Pty Ltd to be satisfied that the environmental risks from each next Stage are acceptable. In addition, formal DSD approvals of revised PEPR / MOPs will be required for:

- Commencement of Stages 1 and 2
- Commencement of Stage 4

A successful conclusion to the trial would be evidence based Revised PEPR / MOPs (for the Long Term Disposal of Salt into F and G Row Pits, and the “Mine Closure” of these Pits) that would have a strong chance of obtaining DSD approval, noted as Stage 5 above.

Table 1.2 Summary of Trial Stages

Tasks	Objectives	Anticipated Outcomes / Information
Stage 1: Preliminary Laboratory and Field Characterisation of Salt/Soil		
1.1 Sampling	Field program to inform Laboratory Testing Program and Field Monitoring Requirements for Field Trial - G Row and F Row Pits	Representative salt/soil samples selected for Testing and Field Trials Salt/soil volumes estimates improved for cut/fill and mass balance
1.2 Laboratory Cylinder Tests	Understand the dissolution rate and longevity of salt attenuation from the salt/soil mixture under: (a) vadose zone with annual climatic inputs and (b) zone of saturation (below brine level or water table) Evaluate Feasibility of the Disposal Strategy to the meet Performance Objectives (Constructability, Landform Stability and Environmental)	Cation and anion concentrations in waste salt/soil leachate characteristic of Pit brine and groundwater chemistry Quantify the concentration of salt in the leachate over time Materials mixing and placement rates and requirements / methods for Field Trial (G Row) developed
Trigger(s) that prevent Stage 2: The results from Stage 1 suggest that dissolution rates of salt, if placed in G Row Pit, would cause a rehabilitated land surface, constructed over a cap over this salt, to undergo unacceptable quantities and rates of settlement indefinitely; and no feasible adaptation of the design or scope of Stage 2 would prevent this. No approval gained from DSD for the measurement criteria for the environmental outcomes from Stage 2		Trigger(s) that require adaptation of design or scope of Stage 2: The results from Stage 1 suggest that feasible adaptation of the design or scope of Stage 2 is necessary to prevent dissolution rates of salt, if placed in G Row Pit, from causing a rehabilitated land surface constructed over a cap over this salt, to undergo unacceptable quantities and rates of settlement indefinitely
Stage 2: Phase 1 (Filling) of Field Trial in G Row Pit (and reporting)		
2.1 Implement Phase 1 (Filling) G Row Pit Field Trial	Construction Phase and Monitoring Phase: Trial placement methods of salt/soil to achieve compaction of material with limited void spaces; Collect field scale data; Validate laboratory data by comparing: - Laboratory data to Field Trial hydrochemical data (G Row Pit) - Laboratory dissolution, settlement/compaction data and Field Trial survey levels data (G Row Pit) Predict longer term performance by water and salt movement modelling to predict seasonality, impacts and settlement model to ultimately evaluate environmental risks and design/ capping performance requirements for final landform	Temporal groundwater levels and salt concentration within and adjacent to the G Row Pit characterised in Field Cation and anion concentrations in 'placed' salt/soil leachate (sampled by pore water samplers in field) characteristic of Pit brine and groundwater chemistry, and Laboratory results Calibration of water and solute transport model achieved Final landform and cover system design options assessed as achievable for the G Row Pit post closure
Trigger(s) that prevent Stage 3: Modelling, based on results from Stage 2, predicts environmental outcomes from Stage 3 that would not comply with relevant required outcomes in the approved PEPR and that cannot be managed by feasible adaptation of its design, construction, monitoring or management. No approval gained from DSD for the measurement criteria for the environmental outcomes from Stage 3		Trigger(s) that require adaptation of design or scope of Stage 3: Modelling based on results from Stage 2 predicts adaptation of the Stage 3 design, construction, monitoring or managements is needed for it to produce environmental outcomes that comply with relevant required outcomes in the approved PEPR and this adaptation is feasible
Stage 3: PEPR / MOP Revision for Stage 4		
3.1 Design Cap and Assess Risk for the long term disposal to G Row Pit	Evaluation of Results from Stage 2 and gain approvals to expand Trials Assess the potential for leachate to detrimentally impact underlying groundwater and adjacent surface water Quantify the potential settlement and impact on vegetation and post closure land use proposed for the G Row Pit, as public open space Modelling to provide long term understanding of sensitivity of the design options and the potential impacts to receptors Design of a cover system, including vegetation, for public open space end-use	Complete the conceptual site model (CSM) Detailed risk assessment showing minimal or no adverse impact on receptors Understand the sensitivity of the design to external influences and over the longer term Develop Rehabilitation Plan and long term Monitoring and Management Plan that will check whether rehabilitation objectives and performance / requirements are being (will be) achieved
3.2 Finalise Plans for Phase 2 (Capping) of G Row Pit Trial	Update CSM Develop Preliminary Risk Assessment for Trial filling in the F Row Pit, utilising lessons learnt from the G Row pit Trial and Laboratory testing results Develop Trial Plan that addresses concepts for the end utilisation of the F Row Pit area (e.g. Open Space & Stormwater Management) and details monitoring requirements, performance criteria for the progressive rehabilitation and stabilisation of the site, and details contingency plans to be implemented in the event that performance criteria are not met	Detailed Risk Assessment showing minimal or no adverse impact on receptors Up-scaled Trial Plan finalised for G Row Pit – to fill void, no cap
3.3 Prepare Plan for Phase 1 (Filling) in the F Row Pit	Present outcomes from G Row Pit Trial and Plans for a) up-scaled Trial in G Row Pit and b) small scale filling Trial in F Row Pit. Satisfy Stakeholder concerns	
3.4: Gain Approval for Stage 4	Prepare a draft revised PEPR / MOP for consultation with all relevant stakeholders that includes plans for: • Phase 2 (Capping) of G Row Pit Trial; and • Phase 1 (Filling) in the F Row Pit	Draft revisions approved through consultation process

Tasks	Objectives	Anticipated Outcomes / Information
Trigger(s) that prevent Stage 4: Evaluation of results from Stage 3, predicts environmental outcomes from Stage 4 that would not comply with relevant required environmental outcomes and that cannot be managed by feasible adaptation of the design, construction, monitoring or management for Stage 4. No approval gained from DSD for the Revised PEPR / Mop for Stage 4		Trigger(s) that require adaptation of design or scope of Stage 4: Modelling based on results from Stage 2 predicts adaptation of the Stage 4 design, construction, monitoring or managements is needed for it to produce environmental outcomes that comply with relevant required outcomes and this adaptation is feasible
Stage 4: Phase 2 (Capping) of G Row Pit Trial and Phase 1 (Filling) F Row Pit Trial		
4.1 Implement Phase 2 (Capping) of G Row Pit Trial 4.2 Implement Phase 1 (Filling) of F Row Pit Trial 4.3 Evaluate Phase 2 of G Row Pit Trial	Collect longer term data for input into modelling to refine predictions of long term behaviour of the cap and stability of the landform. Refine the design parameters for the final cap. Data acquisition and comparisons: - Compare laboratory data and Field Trial data between the G Row pit and F Row pit Trials - Modify and calibrate water and salt movement models to accommodate F Row pit scenario - Run and assess F Row pit Model outputs for Groundwater and solute fate and transport, and Landform stability Risk assessments: - Assess potential for leachate to detrimentally impact underlying groundwater and adjacent surface water - Quantify the potential settlement to impact on vegetation and post closure land use proposed for the F Row Pit, as supra-tidal / stormwater management	Assess Extended Trials and Gain in principal Approval for G Row Pit Closure Plan Final landform and cover system design assessed as achievable for the G Row Pit Closure Plan developed and presented to DSD. Calibration of water and solute transport model achieved Modelling provides long term understanding of sensitivity of the design options and the potential impacts to receptors. Model outputs acceptable. Design and Trial a cover system performance Capping design and performance requirements achievable (feasibility assessment)
Trigger(s) that prevent Stage 5: Evaluation of results from Stage 4, predicts environmental outcomes from permanent disposal that would not comply with relevant required environmental outcomes and that cannot be managed by feasible adaptation of the design, construction, monitoring or management of the permanent disposal No chance of approval from DSD for the Revised PEPR / MoP for Stage 5		Trigger(s) that require adaptation of design or scope of Stage 5: Evaluation of results from Stage 4 predicts adaptation of the design, construction, monitoring or management of the permanent disposal is needed for it to produce environmental outcomes that comply with relevant required outcomes; and this adaptation is feasible
Stage 5: PEPR / MoP Revisions for the Permanent Disposal of Salt to the F Row and G Row Pits (Mine Closure)		
5.1: The Environmental Outcomes Assessment 5.2: Assessments of risks of non-compliance with the outcomes 5.3: Long term Monitoring and Management Plans	Present monitoring and modelling results from Trials in F and G Row Pits Assess Environmental Outcomes and Measurement Criteria for Closure of the G Row Pit; Present outcomes of Detailed Risk Assessments - address sensitivity of the design to external influences and over the longer term Develop and present Rehabilitation Plans and long term Monitoring and Management Plans for the permanent disposal of salt in the F and G Row pits Present risk management controls and contingencies needed to prevent such non-compliance All relevant stakeholders will be consulted about this revised PEPR / MOP so that when finalised and submitted for DSD approval, it can address their legitimate issues	Gain approval for the permanent disposal of salt to the G Row and F Row pits Detailed risk assessment showing minimal or no adverse impact on receptors Understand the sensitivity of the design to external influences and over the longer term Satisfy Stakeholder concerns Revise PEPR to commence Closure Closure PEPR for F and G Row Pits approved

2 Introduction

2.1 Site Details

Buckland Dry Creek Pty Ltd (formerly Ridley Dry Creek) operates the Dry Creek Salt Fields (Figure 1.1), approximately 10 km north of Adelaide, South Australia (CT5913 Folio 768; CT5931, Folio 18; CT5906, Folio 440; CT5931, Folio 18). The site is zoned "Deferred Urban" by City of Salisbury and surrounded predominantly by Industrial and Environmental/Conservation uses with some rural residential and residential development. The site is bounded by Dry Creek to the north, Port Wakefield Road to the east, Salisbury Highway to the south east, Barker Inlet (and wetlands) to the west and south west.

The Dry Creek Salt Fields have been in operation since 1930s, producing chemical grade solar salt (NaCl). Buckland Dry Creek Pty Ltd Corporation is planning to remove surplus salt from Section 1 of the Dry Creek Salt fields. This surplus salt exists in the following forms:

- Crystallised salt in crystallisers and in stockpiles that is suitable for washing and commercial sale.
- Crystallised salt in crystallisers, in the final areas, and in stockpiles that contains sufficient impurities as to be unsuitable for washing for commercial sale.
- Brine muds – which are in effect salt contaminated with soil and salt impregnated soil from the top layer of the floors of crystallisers and final areas.
- Brines from the waste water from salt washing, or from dissolving salt residues.

The removal of this salt will generate:

- Washed salt for commercial sale
- Solid salt residue for disposal
- Brines for disposal into Barker Inlet

The approximate quantities of these forms of the salt have been estimated with the total salt remaining on Section 1 estimated as between 840 – 1100 MT (Table 2.1). Of this approximately 150 – 200 MT is likely to be recoverable for sale and, depending on the proportion lost in brine, 275 - 425 MT will require disposal.

Table 2.1 Estimated Quantities of Salt Remaining in Section 1

Category of Salt Disposed	Estimated Quantity Range (tonnes)	
Washed Salt	150,000	200,000
Waste / Residual Salt	690,000	900,000
To Sea as Diluted Brine	265,000	625,000
Remainder requiring disposal	425,000	275,000
TOTAL	**840,000**	**1,100,000**

This document is concerned with the remaining salt which requires disposal. The disposal to sea as diluted brine is not covered in this document.

2.2 Rationale for Rehabilitation Strategy - Disposal of Salt Residue to Existing Pit Voids

A concept sketch of a rehabilitated site reflective of (a) supra-tidal / Dry Creek overflow (F Row Pit area) and (b) Open Space for recreation (G Row Pit area) is shown in Figure 2.1. The rationale for disposing of salt is based upon the following:

Compatible with future land uses

The PEPR/MOP lists the following potential uses of Section 1:

- Mixed urban use
- Northern connector
- Land fill for raising ground levels
- Stormwater management
- Protection of the urban environment from the effects of sea level rise or land subsidence.

Section 1 is identified as a potential area for urban growth in the *The 30 Year Plan for Greater Adelaide*. The proposed Northern Connector roadway, which links the South Road Superway to the Northern Expressway, has a proposed alignment to the west and north-west of Section 1 and hence screening for aesthetic and noise will be required between any residential development and the roadway. Given the developing agreement for purchase of Buckland Dry Creek by ARR/EPIC Group, it is likely that the majority of Section 1 will be developed for mixed urban use.

Within a developed Section 1, it is highly likely that the area around F and G Row Pits will be required to provide passive open space. In addition, development in this area will necessitate enhancements to the functioning of Dry Creek to reduce peak water levels and improve the quality of water discharged into the intertidal environment downstream. This provides opportunity to cap and contain the waste salt from Section 1 within the Pits and undertake this in a manner which does not limit but facilitates this kind of land use.

Preliminary consultation with Salisbury City Council and with DSD and the Government's Strategic and Technical Advisory Group (STAG) indicates support for this concept, if it can be proven feasible (N J Withers, pers comm).

There is a need to remove salt from the crystallisers

The salt remaining on the surface of the crystallisers is proposed to be removed to facilitate future use for urban development. Although the salt is sodium chloride and unlikely to contain high concentrations of contaminants, it may be classified as a waste and hence leaving the salt in place may result in a more complex approval process for future development. As the salt is not pure enough for sale, it will require disposal.

The current uses and designs of F and G Row Pits are conducive to salt disposal

The "F Row Pit" and "G Row Pit" are located at the northern end of Section 1 (Figure 2.1) and will require reshaping and filling to facilitate future use and rehabilitation of the site. F Row Pit is currently used for storing raw product for magnesium brine production. After crystallisation of sodium chloride (NaCl), runoff of surplus brine from the crystallisers has high magnesium and is directed into F Row Pit. The magnesium brine is then pumped to K Row Pit for further concentration and ultimately sale as a dust suppressant. The brine currently stored in F Row Pit will be removed during summer leaving the Pit empty.

G Row Pit is used to store excess maiden brine (high in NaCl) which is to be held over for the following crystallisation season. The NaCl brine stored in the G Row Pit is traditionally fed by gravity from the G Row Pit into the crystallisers, blended with new brine from the condenser section of the salt field. The brine currently stored in this pit will be pumped to other crystallisers (i.e. not F Row or G Row) to produce salt leaving the Pit empty by the end of the 2016 summer.

The placement of the waste salt in the F Row Pit and G Row Pit, as shown in Figure 2.1, allows disposal of the salt into an environment already high in salt and facilitates the filling and reshaping of the pits for the proposed urban use. The long term placement of the salt will need to consider the potential impact from the dissolution of the salt on the existing surrounding environment, particularly Dry Creek and the underlying groundwater, as well as the potential impact of settlement and salt movement on the future uses of the site.

2.3 Existing environment

A detailed description of the existing environment has been prepared by Tonkin Consulting and is provided in Appendix A (Environmental Site History) and Appendix B (Groundwater Investigation & Baseline Conditions).

2.4 Mitigating Factors for Conduct of Proposed Trial

The disposal strategy presented is considered to provide a workable solution to the management of crystalline salt and saline soil from the salt crystalliser ponds. The staged, field-scale trial aims to demonstrate that disposal of salt/soil within the existing pits can be engineered and managed in such a manner that results in a safe, stable, erosion-resistant, non-polluting and functional final landform that maintains an acceptable impact on the environmental.

There are a number of existing operations and conditions which assist in mitigating the potential for salts and saline leachate to present unacceptable risks of measurable, adverse impacts to the environmental values of the external aquatic intertidal environment of Dry Creek, beyond the boundary of the site. These mitigating aspects are:

2.4.1 Site Conditions and Brine Characteristics

- Both the F and G Row pits were constructed and utilised for the purpose storing commercial quantities of near-saturated sodium chloride and high magnesium chloride brines and have been in continuous operation since the 1970's
- Demonstrated reliability of the pits for containment of brine during operation of the salt fields. Qualitative observation of the good health of mangroves bordering Dry Creek (downstream of the site) over the long period of salt field operations implies that steady state seepage at operational brine elevations in the pits has not resulted in observable adverse impacts to Dry Creek (SA EPA 2009)[1]. This further implies that the seepage flux rates of salts from these pits during these operations have not had a material impact on the salinity of the waters of Dry Creek. The brine elevations from the disposed salts would be managed by design to be lower than those during operation, and thus lower seepage flux rates are expected. The brine concentrations from the disposed salts are expected to be similar to those of the NaCl-saturated brine from the pits and of groundwater in the immediate vicinity of the pits
- F and G Row Pits are constructed on Glanville Formation and Pooraka Formation clays and the G Row pit is lined with locally won clay. The average groundwater hydraulic gradient of these units is of the order of 0.095% and produces very low seepage rates of 0.3 to 0.6 m/year[2] and consequently evaporation from the water table is the principal form of groundwater discharge (Pavelic and Dillon, 1993)[2]. Understanding of hydrogeological characteristics of strata at the pits and clay bunds will be improved through site specific testing during the trial
- The range of composition of the salt/soil for disposal is expected to be similar to the previously stored brines (as both are from the crystallisers). The groundwater is also likely to be similar due leaching from the crystallisers and the groundwater has been seeping into Dry Creek, both of which has occurred over the operational life of the salt field.

2.4.2 Safety in Trial Design

The following safety in design elements of the trial will reduce environmental risks during the Trials:

[1] SA EPA 2009. A risk assessment of threats to water quality in Gulf St Vincent Author: Sam Gaylard. ISBN 978-1-921125-90-X April 2009.

[2] Pavelic P. and Dillon P.J. 1993. Gillman - Dry Creek Groundwater Study: Final Report to MFP Australia. Issue 54 of Report (Centre for Groundwater Studies (Australia). Centre for Groundwater Studies, 1993.

- Scaled and staged trial program;
- Utilising existing structures with historic performance;
- Fill levels will be maintained below historic brine levels;
- Should bunds of the G Row Pit fail, implications will be minimised by the solid nature of the salt/soil fill and the existence of containment drains and bunds, that currently surround the pits;
- The drains which currently contain leachate/brine and will act as seepage interception trenches for the trials. The F Row pit will provide a similar role during the Phase 1 (Filling) G Row pit trial stage. The F Row pit will continue to maintain an area of groundwater depression where any seepage from the G Row pit will be contained under the prevailing hydraulic gradient;
- The hazards presented by the potential failure of the pits is lower than during the operational stages;
- Hydrogeological and hydrological site investigations will be updated during the Trial to develop/improve site wide water balance and groundwater models for the project;
- Proven technology and science will be deployed to manage the pits as capped containment structures.
- Containment in one location provides potential for targeted monitoring and management, and potential future salt recovery should a market develop.

2.4.3 Hydraulic-geochemical considerations

The dissolution rate of NaCl is inversely proportional to the concentration of the liquid medium and tends towards zero as the concentration approaches saturation. In the absence of flux the dissolution rate declines, i.e. without loss (from outward seepage) of saturated brine and its replacement with less saturated brine (from inward seepage or rainfall infiltration) the initial dissolution rate on placement of salt in the pits would decline progressively with time to low steady-state rate. The factors influencing this process are complex and include:

- the characteristics of the unsaturated solution, including temperature, halite saturation degree, flow velocity, turbulence and the concentration of aqueous trace metals;
- the size of salt crystals (affecting surface area to volume ratio);
- structure, texture and variability of the placed salt/soil mix;
- properties/performance of the final cap.
- the matrix permeability to brines of the containing soils (affecting seepage rates)
- convection and diffusion within the inundated salt mass;
- diffusion processes of salt transport through the aquifer in the containing soils (although this is expected to be of second order importance
- the extent to which salt re-precipitation takes place, resulting in clogging and reduction in seepage within the disposed salt

One objective of the trial is to explore the dynamics and rate of salt dissolution under the varying flow regimes and salinities expected within the disposal profiles, initially considering the G Row pit. Therefore the trial will seek to measure the dissolution rate experimentally under both controlled laboratory conditions (e.g. column experiments) and also under the naturally variable field conditions expected (i.e. considered for both the F and G Row pit conditions as illustrated in the site CSM (Figure 2.1)).

Consideration of how these factors could play out for salt disposed in first G and then F Row pits leads to the following propositions:

- Notwithstanding the variability mentioned above, the dissolution rate of salt within the pits will reduce as the initial salinity of the interstitial soil solution increases (Stiller et.al., 2007)[3]. As a result, the dissolution rate for salt disposed in a confining, capped environment above or below a saline water table, would be expected to be slower than for sub-aerial, uncapped, surficial stockpiles of salt.
- For the G Row pit it is expected that infiltrating fresher, unsaturated water will come in contact with the salt/soil, however the salinity of percolating water will increase as a slowly propagating front. As the front propagates the water will become saturated with respect to halite shortly after its initial contact due to the rapid dissolution kinetics of halite (Weisbrod et al., 2012)[4], with a resulting linear decrease in the dissolution rate of salt (i.e. mass halite-flux off the salt/soil per unit area and time) (Stiller et al., 2007)[3]. Salt re-precipitation will then take place and may result in clogging and cessation of downward flows (Stiller et al., 2007)[3]. The saturated salinity front may propagate upward in response to seasonal variations and through capillary action.
- Salt dissolution will be restricted to areas of inflow to the Pits, as once saturated, the solution is unable to further dissolve more salt. A regular supply of fresher water to the salt/soil is not expected once capped and will be controlled by the performance of the cap. Inflows that reach the salt/soil may induce a mass transfer of salt from solid to liquid phase during infiltration (within the infiltration path). This is demonstrated by the linear mass-balance relationship between fresher water inflow and outflow brines (Gechter et al., 2008)[5]; however, in a closed system, the mass of the encapsulated salt will remain constant and re-precipitation of halite will occur below the saturation front.
- The dissolution rate for salt is expected to be slow under the saturated, hypersaline conditions expected at the F Row pit, with limited lateral through-flow of fresher water. In the saturated condition stratification owing to vertical density gradients will likely result in the fully saturated solution occurring within the soil/salt matrix. Below the water table, solution density will be important due to gravitational fractionation and diffusion with the overlying fresher water (seawater) will therefore require hydraulic-geochemical consideration in the design of the capping layer/s.
- In the F Row pit, the rate of dissolution will be greatest where the less dense water remains in contact with the salt and continues the dissolution process while the denser water sinks to the bottom of the pit. This process will be managed through the construction properties of the placed salt (i.e. compaction densities and soil mixing ratios) and cap design. Maintaining a more permeable layer in the upper portion of the cap (i.e. by promoting lateral through-flow above the salt/soil) will improve the hydraulic separation of the disposed salt/soil from tidal waters, whilst also providing a protective measure for maintaining near seawater salinity in near surface sediments.

[3] Stiller, M., Y. Yechieli, and I. Gavrieli (2007), The rate of dissolution of halite in diluted Dead Sea brines, Rep. GSI/1/2007, Geol. Surv. of Israel, Jerusalem.

[4] Weisbrod N., Alon-Mordish C., Konen E. and Yechieli Y. (2012). Dynamic dissolution of halite rock during flow of diluted saline solutions. Geophysical Research Letters, Vol. 39, 2012.

[5] Gechter, D., Huggenberger, P., Ackerer, P. and Waber., H.N. (2008). Genesis and shape of natural solution cavities within salt deposits. Water Resources Research. Vol. 44, Issue 11.

2.4.4 Summary

In summary, the following site conditions and materials characteristics are considered to provide controls that support the proposed disposal strategy:

Table 2.2 Mitigating Factors Reducing Risk during the Trial

Hazard	Site characteristics (to be verified through trial)	Control measure to be assessed in trial
Potential impacts from saline seepage	Slow salt dissolution and seepage rates are anticipated from salt/soil mix due to the demonstrated containment qualities of the clay liner and local hydrogeological setting. Furthermore, the cap function will minimise infiltration to the disposed material, minimising salt dissolution and leachate generation and migration.	Water tightness and strength of the salt/soil mix is to be maximised through placement methods and mixing ratios of soil and salt. Cap will be designed to function as a store-release / phytocap
	The dissolution (weathering) rate of the disposed salt will be slow due to the near saturated condition of interstitial water (solution). Under the disposal conditions the crystalline salt is expected to be sparingly soluble. Mass will be preserved within the pits which act as closed containment cells. Salt in the upper portion of the fine textured profile may dissolve seasonally but will re-crystallise during dryer months through capillary rise.	The containment and capping approach will promote evaporative losses, salt crystallisation and a low or inward hydraulic gradient.
	Potential for environmental impact from seepage is considered low due to the low hydraulic conductivities of the clay liner of the G Row pit and geology of the F Row pit. Seepage from the pits will have similar characteristics to groundwater and will be a diffuse release to a tidally flushed, saline to hypersaline saline receiving environment. Under operational conditions hypersaline water is discharged directly to the surface water environment from point sources.	Potential for impacts are likely to be lower than during site operation due to the predominantly solid state of the salt and controlled 'slow release' containment system. The rate of release will be influenced by the hydraulic properties of the cap and liner, local hydraulic gradients and properties of the brine (e.g. density, viscosity).
Landform stability and settlement	The rate of loss of mass from the disposal areas are expected to be manageable through design. Acceptable rates and limits for settlement will be selected for final, non-sensitive land uses proposed which maintain the functionality and stability of the final landforms.	The landform and cap will be designed to perform under the maximum rates of settlement calculated and tested under the final end land use scenarios conditions. Salt/soil compaction and placement will be tailored to minimise settlement and maximise stability of the final landform.

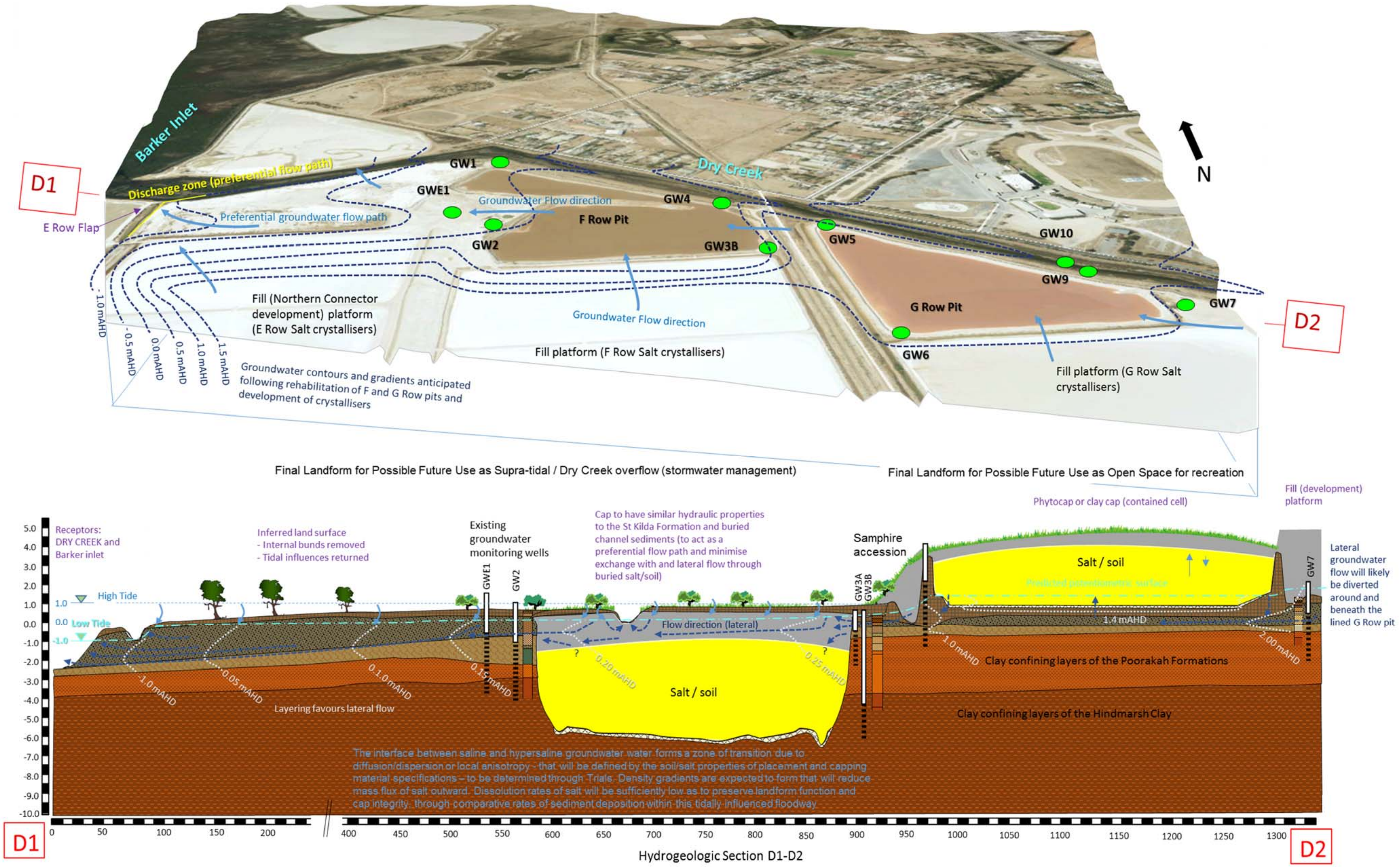

Figure 2.1 Site Location and Features and Concept Sketch of Final Landform for Possible Future Uses

3 Trial Plan

3.1 Stage 1: Preliminary Laboratory and Field Characterisation of Salt/Soil

Stage 1.1: Sampling

Field sampling will be undertaken to characterise the salt/soil materials present at the source site and select representative samples for laboratory testing.

The Pits will be surveyed as required to provide a baseline for the field-scale trials.

Stage 1.2: Laboratory Cylinder Tests

Cylinder tests will comprise (a) leaching tests and (b) column-based trials to measure the chemical and physical stability of the salt/soil and resultant leachate.

The leaching trial will utilise a modified Multi-Element-Parameter (MEP) leach (USEPA Method 1320) to assess the dissolution rate and characteristics of the salt/soil under varying, site specific reagents (i.e. rainwater, seawater, groundwater and brine). Cation and anion concentrations in salt/soil leachate will be compared to groundwater, seawater and near surface groundwater of Dry Creek.

Compaction testing will require that waste salt/soil mixture is compacted in a 2 m length of 200-250 mm diameter rigid walled pipe with a perforated base. Bentonite will be used on the pipe walls to prevent preferential flow along this boundary. A disc permeameter will be placed on the top of the column to provide a moisture wetting front. Electrical conductivity of the leachate and reduction in overall height will be measured regularly during the event. This will be repeated a number of times over a week. The electrical conductivity and dry weight of the waste salt/soil will be measured at the commencement and completion of the trial.

This trial is proposed to understand the dissolution rate and longevity of salt attenuation from the salt/soil mixture under:

- vadose zone with annual climatic inputs and
- zone of saturation (below brine level or water table)

Results will provide an indication of the leachate salt concentrations and potential settlement which may occur at the larger, field scale and ultimately quantify the potential impact on receptors and well as vegetation for the post closure use as public open space and stormwater flood management.

Trigger(s) that prevent Stage 2:	Trigger(s) that require adaptation of design or scope of Stage 2:
The results from Stage 1 suggest that dissolution rates of salt, if placed in G Row Pit, would cause a rehabilitated land surface, constructed over a cap over this salt, to undergo unacceptable quantities and rates of settlement indefinitely; and no feasible adaptation of the design or scope of Stage 2 would prevent this. No approval gained from DSD for the measurement criteria for the environmental outcomes from Stage 2	The results from Stage 1 suggest that feasible adaptation of the design or scope of Stage 2 is necessary to prevent dissolution rates of salt, if placed in G Row Pit, from causing a rehabilitated land surface constructed over a cap over this salt, to undergo unacceptable quantities and rates of settlement indefinitely

3.2 Stage 2: Phase 1 (Filling) in G Row Pit

3.2.1 Stage 2.1: Implement Phase 1 (Filling) G Row Pit Field Trial

The G Row Pit field trial plan (detailed below) will be refined and implemented at completion of Stage 1. The trial will involve the installation of monitoring points followed by the placement of salt/soil (representative) as an instrumented test section of the G Row Pit (Figure 4.1).

The trial is proposed to verify the laboratory cylinder test results with a field scale volume of salt/soil material. Understanding the behaviour of the salt/soil material at a meaningful scale is crucial for considering the impact of variable atmospheric, geological and hydrological conditions required to provide real data on the leachate salt concentrations, moisture movement through the waste salt and potential impacts on groundwater concentrations. The data will assist in completing the CSM, modelling and risk assessment by:

- Quantifying the concentration of salt in the leachate over time;
- Assessing the potential for leachate to detrimentally impact underlying groundwater and adjacent surface water;
- Defining the dissolution rate of salt under field conditions and settlement rates of the structure.

Construction Phase

The G Row Pit has an approximate volume to nominal “top of bank” (3.7 m AHD) of 115,000 m^3. Filling in G Row Pit with the salt/soil will continue until the trial section has been filled to 3 m AHD to enable cover soil (cap) to be placed at Stage 4, if successful.

The instrumented Test Section proposed for the G Row Pit will be constructed in the north western corner of the Pit, nominally 170 m x 85 m (Figure 4.2), equating to 43,000 m^3. Once the Trial section has been filled, a battered edge (1:6) or bund will be constructed to contain the fill. This bund will preferentially be constructed from (or contain a nominal amount of) compacted salt/soil. The amount of salt/soil used in the batter would be dependent on the materials testing results. The toe of the batter will be monitored for seepage and will provide an opportunity to assess different placement and compaction (and mixing) rates for the salt/soil. Further details will be provided on Trial methods and pad size once material characterisation has been completed and placement methods refined.

Sampling of the salt/soil material will be undertaken progressively during placement and also during installation of sensors. To prevent damage to the sensors during construction it is proposed to place install sensors once Test Section has been constructed. It is possible to progressively install the sensors during construction to minimise disturbance; however the risk of damaging the sensors is high and there is potential that the locations are not representative due to placement limitations.

Additional groundwater wells will be installed to intercept water moving laterally and vertically from the Pit. Throughout the G Row Pit Trial, environmental conditions in the F Row Pit will be monitored, particularly for any groundwater seepage occurring from the G Row Pit. The Trial location is ideal for this assessment. Based on groundwater sampling undertaken to date, it is expected that groundwater flows into the F Row Pit will be relatively small, particularly during summer.

Monitoring Phase

It is proposed that monitoring be undertaken over winter when leachate generation is most likely. If the conditions received are drier than average, then opportunities to irrigate fresh water over the instrumented test sections may be explored at a later date. The Trial will create conditions within the profile of the pad to assess dissolution rates and longevity of salt attenuation under both:

(a) unsaturated conditions with annual meteoric inputs and

(b) saturated conditions, below brine level.

Trigger(s) that prevent Stage 3:	Trigger(s) that require adaptation of design or scope of Stage 3:
Modelling, based on results from Stage 2, predicts environmental outcomes from Stage 3 that would not comply with relevant required outcomes in the approved PEPR and that cannot be managed by feasible adaptation of its design, construction, monitoring or management. No approval gained from DSD for the measurement criteria for the environmental outcomes from Stage 3	Modelling based on results from Stage 2 predicts adaptation of the Stage 3 design, construction, monitoring or managements is needed for it to produce environmental outcomes that comply with relevant required outcomes in the approved PEPR and this adaptation is feasible

3.3 Stage 3: PEPR / MOP Revision for Stage 4

3.3.1 Stage 3.1: Design Cap and Assess Risk for the long term disposal to G Row Pit

In this stage the water and salt balance models will be calibrated against field observations and monitoring data. Model results will be used to complete the CSM, design a suitable capping options and inform risk assessment for long term disposal into G Row Pit. The assessment will address:

- The potential for leachate to detrimentally impact underlying groundwater and adjacent surface water under different capping scenarios; and
- Quantify the potential settlement and impact on landform stability, vegetation and post closure land use proposed for the G Row Pit, as public open space,

The risk assessment will include a sensitivity analysis through modelling realistic possible end member values and assist in understanding events or circumstances that may result in an unacceptable impact to receptors.

The seasonal water and salt movement modelling that will be done will enable estimates to be made of a) longer term impacts from leachate on groundwater and the external aquatic environment and b) settlements of the salt. These estimates will be use to assess long term environmental risks and design/ capping performance requirements for a final landform.

3.3.2 Stage 3.2: Finalise Plans for Phase 2 (Capping) of G Row Pit Trial

From Stage 3.1, a Plan for the long term filling of G Row Pit will be developed that describes:

- placement methods;
- capping requirements;
- monitoring activities and measurement criteria (for measurable parameters such as leachate levels and concentrations, salt and cap settlement rates and ground and surface water quality parameters) to check that the required environmental outcomes are being achieved;
- Environmental management controls and contingency measures

3.3.3 Stage 3.3: Prepare Plan for Phase 1 (Filling) in the F Row Pit

From the knowledge gained from Stages 1 to 3.2, a Plan will be prepared for a Trial utilising some or all of the F Row pit. The plan will include

- Construction and monitoring methods (based on those developed and used for the G Row Pit trials to the extent this is appropriate)
- A risk assessment that draws on lessons learnt and results from the G Row Pit Trial.
- The conceptual design of a capping cover system, including vegetation that has potential for stormwater flood management; however the trial will not include capping.

3.3.4 Stage 3.4: Gain Approval for Stage 4

A draft revised PEPR / MOP will be prepared for consultation with all relevant stakeholders. This revised PEPR / MOP will include the plans for:

- Phase 2 (Capping) of G Row Pit Trial; and
- Phase 1 (Filling) in the F Row Pit

This revised PEPR / MOP will also include the Environmental Outcomes and Measurement Criteria for each of these trials. It would also include assessments of risks of non-compliance with the outcomes and of the risk management controls and contingencies needed to prevent such non-compliance.

The draft revised PEPR / MOP will be finalised after consultation and then submitted for DSD approval. It is possible that separate revised PEPR / MOP's would be presented to DSD for approval of each of these trials; however at this time, it is assumed a single revised PEPR / MOP for both these trials would be presented for approval.

Trigger(s) that prevent Stage 4:	Trigger(s) that require adaptation of design or scope of Stage 4:
Evaluation of results from Stage 3, predicts environmental outcomes from Stage 4 that would not comply with relevant required environmental outcomes and that cannot be managed by feasible adaptation of the design, construction, monitoring or management for Stage 4. No approval gained from DSD for the Revised PEPR / Mop for Stage 4	Modelling based on results from Stage 2 predicts adaptation of the Stage 4 design, construction, monitoring or managements is needed for it to produce environmental outcomes that comply with relevant required outcomes and this adaptation is feasible

3.4 Stage 4: Phase 2 (Capping) of G Row Pit Trial and Phase 1 (Filling) F Row Pit Trial

Implementation would be triggered by DSD Approval of a Revised PEPR / MOP containing the plan for this Phase 2 of the G Row Pit Trial. Progress with the trial will be reported regularly and a factual report on the outcomes will be produced and provided to DSD. The details for Stage 4 will be provided in the revised PEPR/MOP but it is envisaged that the following steps wold be required:

- Stage 4.1: Implement Phase 2 (Capping) of G Row Pit Trial
- Stage 4.2: Implement Phase 1 (Filling) of F Row Pit Trial
- Stage 4.3: Evaluate Phase 2 of G Row Pit Trial. Evaluation will inform preparation of the CSM and a Detailed Risk Assessment for the Closure of the G Row Pit. This evaluation will include modelling of the long term fate and transport of salt in leachate and of the long term dissolution rates of the contained salt (and of the consequent settlements of cap and landform over capped salt).
- Stage 4.3: Evaluate Phase 1 (Filling) F Row Pit Field Trial. This evaluation, together with the evaluation of the results of the G Row Pit trial (including the evaluation of the capping performance), will inform preparation of the CSM and a Detailed Risk Assessment for the Closure of the F Row Pit. This evaluation will include modelling of the long term fate and

transport of salt in leachate and of the long term dissolution rates of the contained salt (and of the consequent settlements of cap and landform over capped salt).

From this CSM and Risk Assessment, a Plan will be developed for the Closure of the F Row and G Row Pits that includes design and construction of the capping, and landscaping, the monitoring requirements, performance objectives and reporting schedules. Contingency plans will be included in the event of non-conformances. This closure plan will be canvassed with DSD

Trigger(s) that prevent Stage 5:	Trigger(s) that require adaptation of design or scope of Stage 5:
Evaluation of results from Stage 4, predicts environmental outcomes from permanent disposal that would not comply with relevant required environmental outcomes and that cannot be managed by feasible adaptation of the design, construction, monitoring or management of the permanent disposal No chance of approval from DSD for the Revised PEPR / MoP for Stage 5	Evaluation of results from Stage 4 predicts adaptation of the design, construction, monitoring or management of the permanent disposal is needed for it to produce environmental outcomes that comply with relevant required outcomes; and this adaptation is feasible

3.5 Stage 5: PEPR / MoP Revisions for the Permanent Disposal of Salt to the F Row and G Row Pits

The Closure Plan, for the permanent disposal of salt/soil in the F Row and G Row pit will put into a further revised PEPR / MOP for consideration and approval. Appended to the revised PEPR / MOP will be the CSM and risk assessment. This revised PEPR / MOP will also include:

- Stage 5.1: The Environmental Outcomes and Measurement Criteria for Closure of the G Row Pit;
- Stage 5.2: Assessments of risks of non-compliance with the outcomes and of the risk management controls and contingencies needed to prevent such non-compliance.
- Stage 5.3: Long term Monitoring and Management Plans

All relevant stakeholders will be consulted about this revised PEPR / MOP so that when finalised and submitted for DSD approval, it can address their legitimate issues.

3.6 Timing

The exact timing and rate of works proposed will on many factors. One of these is the progress with other site operations to remove washable salt from the crystallisers, to leave defined areas of waste salt for available for removal to the pits. An approximate schedule is shown in Table 3.1. Materials movement timing is based on haul distance of 2 km and 10 km/hr travel speed of standard 20 m^3 tippers, which results in a turnaround time of around 30 minutes and a minimum of 2 trucks. Timings will need to be reviewed as the program progresses.

Table 3.1 Approximate and Indicative Schedule for the proposed works

Stages	Task	Estimated Duration	Duration
	DSD approval for Revised PEPR / MoP for Stage 1 and 2		End Jul 2016
1.1	Sampling and Survey	1 month	Aug 2016
1.2	Column leaching Trial	2 months	Sep and Oct 2016

Stages	Task	Estimated Duration	Duration
2.1	Phase 1 Trial in G Row Pit Instrument Area (approx. 43,000 m^3) completed in north of G Row Pit (approx. 3 months to fill – if 15,000 m^3 placed per month, plus then 3 months further trial monitoring). (total effective monitoring period assumed = 5 months)	6 months	Oct 2016 to Mar 2017
2.1	Monitoring equipment and additional groundwater wells installed in G Row and F Row Pits	0.5 months	Oct 2016
3.1	Evaluate Phase 1 Trial results	3 months	Apr 2017 to Jun 2017
3.2	Finalise Plans for Phase 2 of G Row Pit Trial	3 months	May 2017 to Jul 2017
3.3	Prepare Plan for Filling trial in F Row Pit	2 months	Jun 2017 to Jul 2017
3.4	Prepare and gain approval for PEPR / MOP Revision for Stage 4	3 months	Aug to Oct 2017
4.1	Phase 2 G Row Pit Trial Filling (72,000 m^3) (approx. 5 months to fill – if 15,000 m^3 placed per month) Capping and Monitoring	8 months	Nov 2017 to May 2018
	Further Monitoring (total effective monitoring period assumed = 12 months)	6 months	Jun 2018 to Nov 2018
4.2	F Row Pit Trial Filling (250,000 m3 @ 15,000 m3 / month) and Monitoring	17 months	Nov 2017 to Mar 2019
	Further Monitoring	7 months	Apr to Sep 2019
4.3	Evaluate G Row Pit trial	3 months	Dec 2018 to Feb 2019
4.4	Evaluate F Row Pit Trial	3 months	Oct to Dec 2019
5.1	Prepare and submit PEPR / MOP Revision for Permanent Disposal into and Closure of G Row Pit	3 months	Mar to May 2019
5.2	Prepare and submit PEPR / MOP Revision for Permanent Disposal into and Closure of F Row Pit	3 months	Jan to Mar 2020
NOTE: Duration of filling tasks is based on 30 min turnaround time and 2 trucks (20 m^3 tippers) working 40 hours/week			

4 Phase 1 (Filling) Trial in G Row Pit

4.1 Trial Objectives

There are limited solutions for the removal and co-disposal of salt/soil at the site, with the most obvious solution to place the material in F Row and G Row Pits, which require decommissioning. Disposal of salt/soil to F and G Row Pits has potential to improve both areas of the site if managed in an environmentally acceptable and technically and economically viable way.

The aim of the proposed trial is to demonstrate that disposal of salt to the Pits can be designed to provide a remediation solution that has no adverse impacts to the existing environment. To demonstrate this, the objective of the trial is to provide scientifically measureable data to support a defensible design strategy. The specific objectives are:

1. Understand the dissolution rate and longevity of salt attenuation from the salt/soil mixture;
2. Quantify the concentration of salt in the leachate over time;
3. Assess the potential for leachate to detrimentally impact underlying groundwater and adjacent surface water;
4. Quantify the potential settlement and impact on vegetation or the post closure use as public open space and stormwater flood management;
5. Complete the conceptual site model (CSM)
6. Understand the sensitivity of the design to external influences and over the longer term.

4.2 Preparation

Brine stored in G Row Pits will be removed prior to placement of the waste salt/soil. Once the commercially-viable salt has been removed from the crystallisers and the salt washed, the material left on the surface of the crystallisers will be removed by grading or scraping the salt layer and a thin layer of the underlying materials. The depth of removal of the underlying soil material, believed to be locally won clay, will be limited as far as practical.

A haul road will be constructed to the G Row Pit to facilitate truck movements and assist in dust control. It is not proposed to remove the salt crust in the base of the Pit or undertake any grading or other preparatory works within the Pit; however access to the Pit may be facilitated by breaching the Pit's bund wall or by constructing an earthen ramp.

New monitoring wells will be installed in the G Row Pit bund wall. Two wells will be installed adjacent to the proposed instrumented test section and existing wells 3 and 3A. These wells will target the groundwater aquifer and the Hindmarsh clay to provide a toposequence toward the groundwater depression (i.e. F Row Pit).

Three wells will be installed to the south of the F Row Pit. These wells are to measure the standing water level response in the near surface aquifer and Hindmarsh Clay aquitard at locations further from the F Row Pit groundwater depression.

Additional wells will be installed north and east of the Trial Pad to intercept seepage toward Dry Creek, where tidal influences are more pronounced. Wells will be installed within the Pit to assess any changes in salt concentration due to the placement of the salt/soil mixture in the Pit.

Three new monitoring wells will be installed in the G Row Pit bund wall adjacent to the proposed instrumented test section (Figure 4.1).

The objective of groundwater monitoring wells is to (i) target lateral flows within preferential pathways, within the St Kilda Formation, and vertical and lateral flow that may occur within the Hindmarsh Clay, which is anticipated to be a confining layer. The locations of the groundwater wells and Trial Pad instrument nests will be surveyed.

4.3 Filling

It is proposed to commence filling at the northern corner of the G Row Pit and progress placement in 30 m wide strips in a southerly direction (see Figure 4.1). Material will be dumped onto the pit surface from the trucks and then spread in approximately 0.5 m lifts using earthmoving equipment, e.g. grader or dozer. In G Row Pit, waste salt/soil will be placed to 0.5 m below the top of the bund walls to enable the stable placement of a clean fill layer (nominally 0.5 – 0.7 m thick) to allow for an interim cover of shallow-rooted grasses and salt tolerant vegetation to be established, post-Trial assessment.

In Row G Pit, the finished surface will be mounded with resultant grades of 2 – 5 % from the centre to the bund walls to prevent ponding which may lead to differential settlement.

It is not proposed to moisture condition the waste salt/soil to facilitate maximum compaction but rather to achieve a uniformly firm, unyielding surface to minimise settlement. It is estimated that compaction of 85-90% maximum dry density is likely to be achieved by track rolling and vibrating roller, if required. If the surface is not firm, then thinner lifts or alternate placement methods may be investigated.

Priority will be given to completing the instrumented test sections to the full thickness to facilitate instrumentation and data collection as soon as possible.

4.4 Monitoring

The primary objective of the Trials is to obtain scientifically valid data, under field conditions. Monitoring equipment will be installed into the instrumented Trial area to collect data needed for design support and regulatory approval of the final solution.

The monitoring requirements to meet the specified objectives consists of material characterisation, soil moisture content, leachate concentrations and groundwater level, salinity and chemistry, as shown in Table 4.1.

Table 4.1 Monitoring Required to Meet Trial Objectives

Objective		Monitoring required
1	Dissolution rate Longevity of salt attenuation	Material salt concentrations and moisture content over time
2	Leachate salt concentration over time	Soil pore water samplers
3	Potential for detrimental impacts to groundwater and surface water	Soil moisture content Pore water samplers Groundwater levels and salt concentrations in and around the Pits
4	Potential settlement and vegetation impacts	Height/weight changes in columns; Topographic survey Material characteristics before and after leaching
5	Complete CSM	Material characteristics Porewater samplers (leachate salt concentration) Settlement rate – see Objective 4
6	Design sensitivities	Inputs to salt and water balance modelling are: Material characteristics Moisture content through profile Groundwater level and salt content Surface water level

During installation of monitoring equipment, samples will be recovered and analysed for pH, salinity and major cations and anion concentrations. During the Trial it is proposed to monitor along two transects in the instrumented Trial area being at the embankment, 20 m into the waste salt/soil and a further 25 m into the waste salt/soil (Figure 4.2). A summary of the monitoring for each pit is shown in Table 4.2. At each sensor location it is proposed to monitor:

- Soil moisture content at four depths in the waste salt/soil and two depths in the bund wall at the interface;
- Soil pore water salinity at 0.5 m depth and immediately above the Pit base.

Table 4.2 Summary of Monitoring

Sensor	G Row Pit
Pore water samplers	4 (2 locations; 2 depths)
Soil Moisture Content	10 (3 locations; 2-4 depths)
Groundwater Wells	1 existing + 3 new (clustered)

The approximately location of the sensors through the placed waste salt/soil is show in Figure 4.3. The soil moisture sensors will be selected based on tolerance to highly saline conditions, e.g. MP406 or Theta probe sensors are highly tolerant to salinity and readings are only marginally affected.

It is proposed to install ceramic cup pore water samplers to enable collection and analysis of the leachate generated from the waste salt/soil; however, if combined soil moisture and salinity sensors can be located which can read at extremely high salinities (expected to be >20 EC units in the waste salt/soil) then these may be installed instead. The depth to groundwater and salinity will be measured on a monthly basis with samples submitted to the laboratory for analysis is the salinity changes by > 10% from background.

4.5 Trial Supervision, Management and Maintenance

Buckland Dry Creek Pty Ltd has company-wide procedures on incident management, investigation and reporting, emergency response and document, data and records and it is proposed that the management and monitoring during the trial will comply with these standard operating procedures. Buckland Dry Creek Pty Ltd will develop site-specific management plans for the Trial area.

During the Trial, Tonkin Consulting will provide support to Buckland Dry Creek Pty Ltd and analyse collected data on a regular / monthly basis. Tonkin Consulting will also assist Buckland Dry Creek Pty Ltd in developing data quality protocols for monitoring data. At the following milestones, an assessment of site conditions will be undertaken:

- Prior to construction sing the data from the Column Leaching Trial. The leaching trial provides preliminary data that will assess the potential for changes and impact to occur. Preliminary water and salt balance modelling will be undertaken at this step to identify sensitive design elements and confirm adequate monitoring of the instrumented test section;
- Three months after sensor installation to ensure correlation of collected data;
- Six months after sensor installation to assess if weather conditions have been conducive to dissolution and leaching of salt or if irrigation should be applied to the instrumented Trial area to provide data under saturated conditions.

4.6 Longer Term Impact Assessment

4.6.1 Hydraulic and Salt Modelling

Hydraulic and salt modelling will be used to understand the potential impacts of the proposed salt disposal to the G Row Pit over the longer term. The collection of field data will enable the calibration of the selected model to ensure it represents field conditions and hence improve the accuracy of modelling predictions.

Once calibrated, the model can be used to understand the potential for impacts to the surrounding environment over the longer term. This up-scaling to full-scale (for filling the remainder of the G Row Pit) over time is achieved by running the calibrated model for a longer timeframe of climatic conditions.

By using historical climate data, the effect of the extremes of weather conditions on the waste salt can be simulated. For Dry Creek Saltfields, Bureau of Meteorology weather stations are located at Dry Creek, Pooraka, Parafield, Bolivar and Torrens Island. Not all data are collected at all stations, with Parafield Airport (Station 023013) the only station collecting a range of weather data since 1929. The SILO database will be used to create a patched point data set from all available surrounding stations from 1965 until 2015, i.e. 50 years of data.

In addition, the water balance model will be used to assess the impact of placing different cap types over the salt/soil. One cap type which is conducive to growing plants is the phytocap, which relies on soil moisture storage and evapotranspiration to control drainage through the cap and prevent contact with the underlying waste salt and soil.

The second is a barrier cap which uses a compacted clay or geomembrane liner to prevent movement downward. The barrier caps limit the potential for growing deeper rooting plants and hence may not provide the aesthetic vision for the site. In both cases it will be prudent to place a capillary break beneath the cap to limit the movement of salt upwards through the profile.

Models will be developed using the data collected to consider the impacts of placing salt/soil waste below the water table. This process will enable a risk assessment and Trial Plan to be developed for the F Row Pit.

Figure 4.1 Concept Plan of Proposed Filling Plan and Location of Instrumented Trial Area

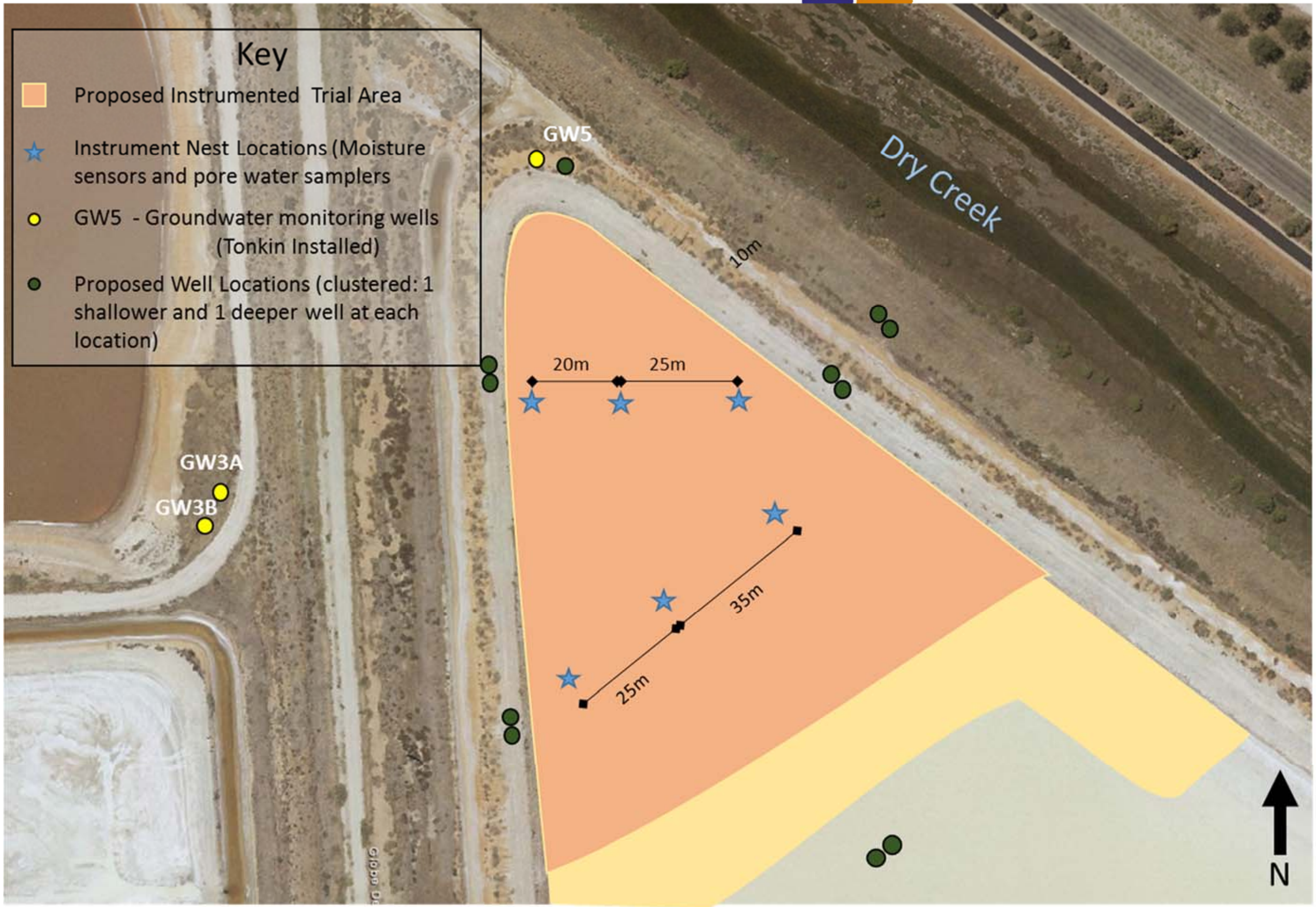

Figure 4.2 Concept Plan View of G Row Pit Instrumented Test Section and Approximate Location of Monitoring Equipment and Wells

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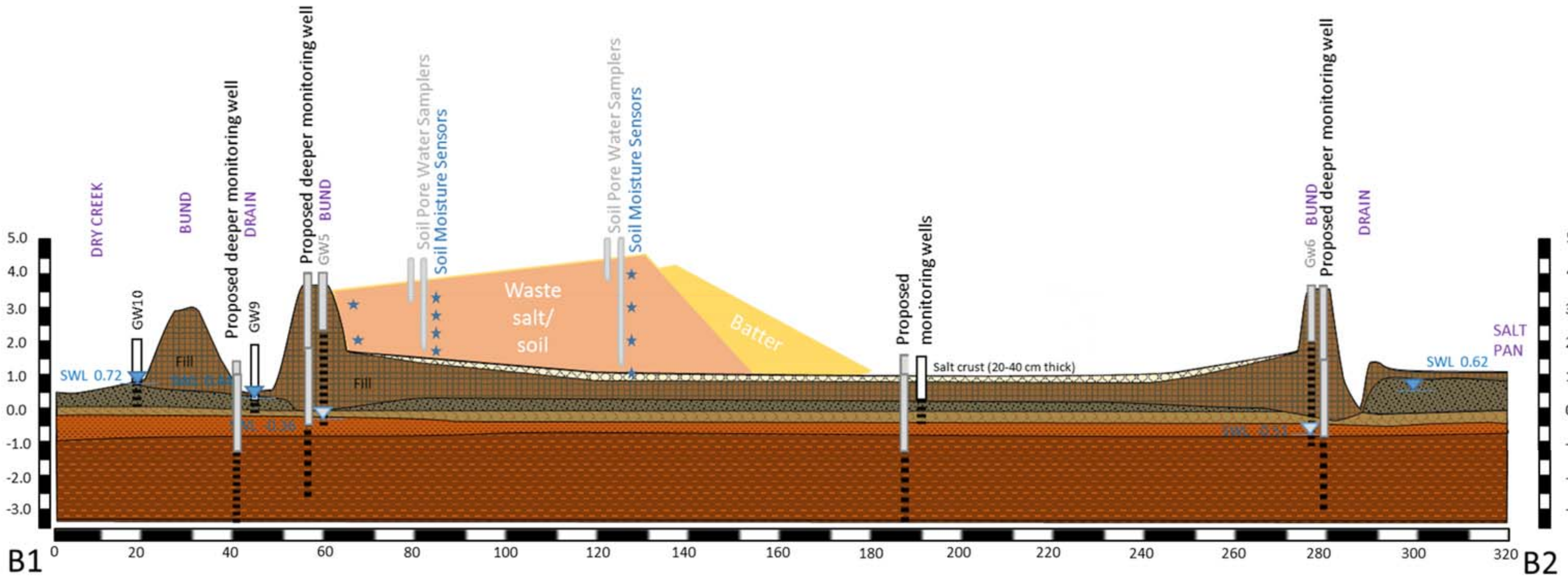

Figure 4.3 Cross-Sectional Concept Plan of G Row Pit and Instrument Installation

5 Environmental Outcomes and Measurement Criteria

5.1 Scope of Operations

The existing operations covered under the PEPR/MOP for Section 1 are:

- Pumping bore water from the T1 aquifer and sea water to dissolve or wash salt
- Excavation of salt from crystallisers and loading this into trucks for transport to stockpile or to an on-site salt washing plant
- Washing salt to stockpile
- Loading salt from stockpile into trucks for transport off-site
- Pumping “MagBrine” into a tanker for use on site or for transport off-site
- Workshop operations for the maintenance and repair of equipment
- When permitted, the pumping of diluted waste brine from salt washing into sea water
- Storage of waste brine from salt washing or brine from dissolved salt
- Recrystallization of brine in crystallisers
- Maintenance of existing roads and bunds
- Environmental management as per the existing management plans and procedures
- The operations of the site office

The removal and transport of the waste salt into the G Row Pits will include excavation from the crystallisers, loading into trucks for transport and maintenance of existing roads and bunds. The minor difference between the operations required for the Trial operation and the operations listed in the PEPR/MOP is the storage of waste salt rather than waste brine. Given that the waste salt does not include the leaching and transport mechanism of water, it is likely to represent a similar (not greater) risk than the storage of brine or waste brine in the Pit. In addition, the proposed monitoring will require the installation of new groundwater wells (under permit from DEWNR) and the use of a drill rig; though not explicitly covered in the listed operations, this would be covered by the existing environmental management plans and procedures in the event that existing site groundwater wells require replacement. Overall, the proposed operations to construct the trial are within the scope of operations currently included in the PEPR/MOP.

5.2 Environmental Outcomes and Risk Assessment

The work for Stage 1 involves sampling and laboratory testing of waste salts and this kind of work is covered by the existing, approved PEPR / MOP. The PEPR/MOP defines ratings for consequences and likelihood of an event and the overall risk rating (Table 10 and 11). These same criteria have been used to assess potential risks of no-compliance with the PEPR/MOP’s environmental outcomes arising from the Stage 2 and 3 trial works involving the placement of the waste salt/soil into the G Row Pit and the F Row Pit (see Table 4.1). This table presents this assessment or risks, assuming the comments and controls, and measurements described in the Table apply. The conclusion from this risk assessment is that risks from the conduct of Stages 2 and 3 of the trial are negligible to low.

Table 4.2 provides a preliminary and illustrative assessment of risks to the potential impacts to groundwater, surface water; the future land uses (from subsidence), and site workers from the longer term disposal and capping of waste salt/soil into the G Row Pit. This assessment will be reviewed, expanded and revised in light of the results from Stages 1 to 3 of the trial. Furthermore, at the appropriate time an equivalent risk assessment for the F Row pit will be prepared. However to do so now would be premature.

Table 5.1 Overall Assessment of Risks and Risk Management for Proposed Stage 2 and 3 Trial Works

Key Environmental Value	Required PEPR/MOP Outcome	Outcome Relevant for the Proposed Trial Works	Risk event	Comments	Consequence = level of impact relative to the Required Outcome	Likelihood (during trial)	Risk Rating = risk of non-compliance with PEPR / MOP Outcome	Proposed Controls (during trial)	Measurement (during trial)
Health of site workers / users	N/A	N/A	Impacts from salt exposure to skin or eyes	The existing site OHS controls will be used	Low	Probable	Low	As per current approved PEPR/MOP	As per current approved PEPR/MOP
Air quality	No adverse public health and/or significant nuisance impact due to air emissions, dust, pest insect species, odour or noise	Yes	Dust generated from excavation and placement of material	Works proposed are similar to the historic excavation and transport of salt that have occurred in Section 1. Note: odours, pest, insect issues unlikely to be generated by the trial works	None to Low impact	Unlikely	Negligible	As per current approved PEPR/MOP	As per current approved PEPR/MOP
Flora and fauna	No loss of abundance or diversity of native vegetation on or off Sections 2 to4 of salt field through clearance arising from Holding Pattern, unless prior approval under relevant legislation is obtained	No	None	N/A. The works are in Section 1 not Sections 2 to 4	N/A	N/A	N/A	N/A	Not required
	No adverse impacts to aviflauna using the site beyond internationally recognised impact thresholds, or outside historic ranges of variability in species and bird numbers	No	None	N/A. Avifauna use of Section 1 is not significant	N/A	N/A	N/A	N/A	Not required
Land use	No compromise to potential future land use No adverse impacts to adjacent land use	Yes Yes	In crystallisers - over excavation of soil with salt exposing ASS and introducing this ASS into F or G Row Pit.	Control depth of removal of soil with salt, so that the engineered floor of the crystallisers is not penetrated. The controlled excavation of salt is an established operation in Section 1 conducted with practised procedures and management	None to Low	Unlikely	Negligible	As per current approved PEPR/MOP.	As per current approved PEPR/MOP
			Settlement of salt / soil in pits	This risk event becomes relevant after a successful trial.	N/A	N/A	N/A	N/A	Not required
			Salt and saline soil in pit preventing rehabilitation over Pits	This risk event becomes relevant after a successful trial, but not during the trial. When this becomes relevant, the risk will be controlled by a) construction of a suitably designed cap to prevent capillary rise and to provide a base for a landscaping layer of soil for plant growth; and b) use of native vegetation suitable to highly saline coastal environment	N/A	N/A	N/A	N/A	Not required

Key Environmental Value	Required PEPR/MOP Outcome	Outcome Relevant for the Proposed Trial Works	Risk event	Comments	Consequence = level of impact relative to the Required Outcome	Likelihood (during trial)	Risk Rating = risk of non-compliance with PEPR / MOP Outcome	Proposed Controls (during trial)	Measurement (during trial)
Surface water	No adverse impacts to adjacent land use No adverse impacts on the environmental values of marine waters due to water discharge	Yes Yes	Leachate from salt in G Row Pit affecting salinity in Dry Creek and marine environment	Leachate most likely to preferably enter a) the seepage drains around the pit; and b) F Row Pit. Some may seep through the floor of the pit to reach groundwater and thence Dry Creek. The leachate that enters the drains can be pumped either elsewhere in Section 1 for evaporation or into F Row pit if not yet used for the trial). The purpose of the trial is to collect data to assess if this leachate can affect the salinity in Dry Creek. The data will include salinity and water level measurements in groundwater wells around the pit, salinity measurements in Dry Creek, and salinity and leachate level measurements in the pit. Leachate that enters Dry Creek via seepage to groundwater will do so slowly and with reduced concentrations because of the properties of the Hindmarsh clays of the groundwater aquifer	None to Low	Probable	Low	Pit Constructed to store brine and is in operational condition. Exiting clay bunds and clay lined floor. Trial and assessment period finite (9-12 months) Management of the leachate level in the pit, with a contingency available to drain it directly from the pit into the external drains; both with the intent to reduce the flux of salt along pathways to Dry Creek The ultimate contingency would be to remove the salt from the pit.	Monitoring of salinity in Dry Creek upstream and downstream of F and G Row Pits. No significant measurable increase in the salinity of water of Dry Creek during low flow periods on outgoing tides Permeability (& variability) of shallow aquifers restricted to St Kilda Formation and top of Glanville Formation. Monitor and Model - Salt/Groundwater fluxes - seasonal variations. Tidal influences. Salt fate and transport Data to support development of a meaningful assessment of long term risks and develop risk management options required to up-scale to full scale – so that all potential pathways can be assessed, changes monitored and transport managed
			Leachate from salt in F Row Pit affecting salinity in Dry Creek and marine environment	Leachate can only enter Dry Creek if its level in the pit is above the water level in Dry Creek. The trial will be conducted with control of this leachate level. Part of the trial will involve a leachate level below, and part a leachate level above the low water level in Dry Creek. The purpose of the trial is to collect data to assess if this leachate can affect the salinity in Dry Creek. The data will include salinity and water level measurements in groundwater wells around the pit, salinity measurements in Dry Creek, and salinity and leachate level measurements in the pit. Leachate that enters Dry Creek via seepage to groundwater will do so slowly and with reduced concentrations because of the properties of the Hindmarsh clays of the groundwater aquifer	None to Low	Probable	Low	There is part of the pit between what will be filled and Dry Creek. During the trial, the brine level in this part will be controlled just below Dry Creek low water level by pumping, with the discharge being either recycled to the main part of the pit or sent elsewhere in Section 1 to evaporate. This pumped part of the pit will act as a sump to collect a significant proportion of the leachate from the pit. As a further contingency, leachate levels within the filled pit could be controlled by pumping. The ultimate contingency would be to remove the salt from the pit.	

Key Environmental Value	Required PEPR/MOP Outcome	Outcome Relevant for the Proposed Trial Works	Risk event	Comments	Consequence = level of impact relative to the Required Outcome	Likelihood (during trial)	Risk Rating = risk of non-compliance with PEPR / MOP Outcome	Proposed Controls (during trial)	Measurement (during trial)
Groundwater	No adverse impacts on other groundwater users	Yes	Leachate or groundwater intrusion results in increasing groundwater salinity and affecting other users	Groundwater in Quaternary aquifer currently saline. Base of Pits is likely to be clay as were used to hold operational quantities of brines. The zone of groundwater around the pits impacted by leachate is likely to be limited in lateral dimensions and also not reach deeper aquifers. There are unlikely to be other human uses of this groundwater because of its existing condition and the low yield of the aquifer. The prime use of groundwater in the potentially impacted parts of this aquifer is to supply the adjacent Dry Creek and the intertidal land downstream.	None to Low impact	Unlikely	Negligible	See Surface Water	Monitoring groundwater within F Row Pit and in bund walls of F and G Row Pits. Data confirms attenuation of salinity with limited distance from these pits
Noise	No adverse public health and/or significant nuisance impact due to noise	Yes	Machinery and trucks generate significant noise	Works proposed are similar to the excavation and transport of salt, and with the same controls	None to Low impact	Unlikely	Negligible	As per current approved PEPR/MOP.	As per current approved PEPR/MOP
Heritage	Not required		None	See Section 8.9 of current approved PEPR/MOP	N/A	N/A	N/A	N/A	Not required

Table 5.2 Preliminary Risk Assessment for the envisaged Long Term Rehabilitation of the G Row Pit

Scenario		Key Environmental Value	Risk event	Consequence	Likelihood	Risk Rating	Proposed Controls (Developed from Trial outputs)	Measurement (Target for Monitoring potential impacts)
Capping Pit and initiating final land-use as open space (closure)	G Row Pit	Shallow groundwater ecosystems / users (existing)	Dissolution rate of salts high Leachate composition sufficiently different from groundwater composition as to impact receptors Direct pathways exist Solute transport occurs at rates unacceptable rates – impact receptors	Low	Probable	Low	Cap design to control infiltration and dissolution Cap design to be resilient to change and maintainable Performance of clay bunds and lined floor to meet acceptance criteria Final salt/soil compositions (or additives) will be performance based to minimise subsidence, (and permeability)	G Row pit – raised, vegetated landscape (Phytocap function – must meet performance criteria) Permeability (& variability) of shallow aquifers. Salt/Groundwater fluxes - seasonal variations. Cap performance. Salt fate and transport.
		Groundwater ecosystems / users and Surface waters, flora, fauna of Dry Creek / Barker Inlet		Moderate	Unlikely (considering Pit construction)	Low		
		Cap subsidence impacts on land-use	Dissolution rate of salt is sufficiently high as to cause unacceptable deflation rates of the final landform – considering land-use and regional rates of subsidence	Low (considering open space recreation)	Probable	Low		
		Site workers	Direct contact	Low	Probable	Low	Under current site management and proposed WH&S	
		Human users and ecosystems of the land over the pits		Low	Rare	Negligible	Final landform and cap will provide a barrier	

5.3 Proposed Measurement Criteria

The environmental measurement criteria for the demonstration of compliance with the Environmental Outcomes are listed in Table 30 of the PEPR (and summarised in Table 1.1 of this document). The Measurement Criteria listed in Table 30 will remain the same for the trial and have been iterated in Table 1.2. Salinity is currently measured to ensure no adverse impact to the environmental values of the marine environment due to water discharge.

The leading and lagging indicators for the trial are:

- Leading Indicators:
  - Salinity in pore water samplers
  - Seepage into surrounding drainage channels;
  - Salinity and cation concentrations in groundwater wells around G Row Pit
- Lagging Indicators
  - Seepage into Dry Creek
  - Salinity and cation concentrations in groundwater wells at site boundary
  - Seepage into E Row flap

5.3.1 Proposed Controls / Contingencies for Stage 2

The following controls will be employed in the G Row Pit in the event that the disposal methods are not considered appropriate:

- Control hydraulic gradient to receiving environment by manipulating water / brine levels within the pit. A sump with a means to drain it to an external drain would allow for brine levels to be dropped to the level of the pit floor, if need be.
  - We will monitor changes and rates of change in levels, and salinity (Piper Plot) in the monitoring wells. We will also monitor upstream and downstream in Dry Creek. If we see significant deleterious change we can lower the water / brine level in the Pit, and monitor responses
- If the Trial and modelling demonstrates that long term storage in the Pit under a cap is not acceptable, then we may need to remove the salt over the short to medium term, maintaining control on the hydraulic gradient
  - How we achieve that is yet to be determined, but one option under consideration is the excavation and removal of the salt / soil mass to elsewhere in Section 1
  - Another option may be to use the Pit to slowly dissolve the salt into brine which is then discharged under Licence in a controlled manner into the intertidal environment.
  - We shall propose feasible triggers for these two management actions.

5.4 Trial Reporting

The proposed frequency of reporting of progress of the Trials and of compliance with the Environmental Outcomes listed in Table 1.1, will be undertaken in accordance with the Table 1.2 (Summary of Trial Stages) and that agreed with DSD. Compliance reporting and greater than 6 non-compliance reporting will be as per the current approved PEPR / MOP.

6 References

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