ADDENDUM TO THE 2007 ENVIRONMENTAL STATEMENT:

DRY GUT OPEN CHANNEL

June 2013

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LIST OF ACRONYMS

ADA	Airport Development Area
ADAB	Airport Development Area Boundary
ADOA	Airport Development Order Area
ADT	Articulated Dump Truck
BR	Basil Read
CEMP	Contractor's Environmental Management Plan
EAA	Eastern Arid Area
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Statement
LEMP	Landscape and Ecological Management Project
PBP	Prosperous Bay Plain
RESA	Runway End Safety Area
SHG	St Helena Government
TSP	Total Solid Particulates

EXECUTIVE SUMMARY

The original reference design for the St Helena Airport Project proposed that two closed concrete culverts be constructed underneath the Dry Gut fill to convey any runoff from the Dry Gut catchment and the south-western portions of the airfield footprint. One culvert was proposed for operation and the other to serve as a backup in the case of an emergency and to provide safe access for any maintenance requirements. At tender stage, Basil Read (BR) proposed that the above system be replaced by a single closed culvert coupled with a temporary attenuation dam upstream of the culvert in Dry Gut to prevent any storm water flow from entering the bulk fill works area.

During the design stage a number of alignment options were investigated for the culvert, but significant risks were associated with each, relating primarily to the risk of culvert subsidence.

In addition to the above, an increase in the quantity of unsuitable bulk fill material has resulted in a shortage of approximately 800,000 cubic meters of quality fill material to construct the Runway End Safety Area (RESA) over the Dry Gut valley.

A solution is required to address the above mentioned two issues: drainage of storm water from Dry Gut away from the toe of the rock fill; and a source of suitable rockfill material. The option of constructing an open diversion drainage channel on the southern side of Dry Gut provides a sound engineering solution to solve both these problems, whilst also providing effective long-term maintenance solutions for the Dry Gut catchment area.

In view of the proposed changes to the reference design (2007) and the fact that some of the work will take place outside the agreed Airport Development Area (ADA), it was determined that planning permission was required for the proposal and a screening opinion[1] was requested from the St Helena Government (SHG). The response received from Mr. A Isaac of the St Helena Planning Division in a letter dated 5th April 2013 indicated that a baseline invertebrate survey would need to be undertaken to determine whether the development would have a significant impact on the invertebrates in the area in question and that, if any impacts are identified, appropriate mitigation measures should be proposed (Appendix A). However, it was also acknowledged that a substantial EIA had already been done (Faber Maunsell, 2007) and that parts of this would still be relevant. Thus, the Planning Division suggested that the study should be treated as an Addendum to the original Environmental Statement (2007 ES). The survey of the invertebrates (and lichens) of the study area is included in Appendix B.

This report provides the SHG with a brief overview of the proposed project and an assessment and comparison of the environmental impacts associated with:

1 the new open channel compared to the culvert and attenuation dam option; and

2 the new source of suitable fill from the southern side of Dry Gut, compared to any other source area.

[1] In terms of s.32 of the Land Planning and Development Control Ordinance, 2008

Open channel compared to the culvert and attenuation dam

The study shows that the open channel will hold some advantages over the culvert and attenuation dam option and some disadvantages, as summarised below.

The advantages will be:

- Less land take than the temporary attenuation dam and haul and maintenance road for culvert;
- Lower carbon emissions than constructing a culvert and dam wall;
- The area is outside of and not abutting a proposed national protected area;
- Lower visual impact;
- The normal flow in lower Dry Gut and associated aquatic flora and fauna downstream of the fill will not be adversely affected;
- The presence of an open water course will provide a newly created habitat for reinstatement;
- No impact on Wirebird habitat in the area of the open channel proposal.

The main disadvantages will be:

- An increase in land take of 1.7 ha outside of ADAB (2011); but an increase in land take of only 0.7 ha compared to 2007 ES;
- A greater impact on rare lichen in the lower reaches of Bencoolen;
- A greater impact on invertebrate species in the valley to the south of Dry Gut.

Both design options would have required significant earthworks, with the open channel requiring more blasting than the reference design, but the proposed work area is further away from sensitive receptors and therefore the impact of noise, dust and vibration will be less.

New source of suitable fill material from the southern side of Dry Gut

The second comparison is more difficult to evaluate because no alternative source of suitable rock fill material within the ADAB (2011) has been identified. Assuming that the cliffs and outcrops are all a potential source of suitable material, and assuming that these habitats all seem to house a number of endemic, rare species, it stands to reason that most, if not all, potential sources of fill would have similar sensitivity to disturbance. Added to that, the cliffs and rocky outcrop areas tend to be more visible from vantage points across the island and therefore most quarrying activities will have a visual impact on either residential areas or scenic walks.

A further consideration is that any other source of rock outside of the ADAB/ADOA fill will have to be accessed, meaning that a new haul road would have to be created – which in itself would have a potential impact on land take, invertebrates, lichens, flora, and aesthetics (dust, noise and visual). It is therefore considered likely that no other sources of suitable rock fill can be found within or outside of the existing ADAB which would not have an equal or greater impact on the environment than the one proposed in Dry Gut.

There are a number of advantages to the Dry Gut open channel excavation over other possible quarries outside of the ADAB (2007):

- The hauling distance to the Dry Gut fill area is relatively short, thus reducing greenhouse gas emissions, dust and noise impacts;
- The access road to the south side of Dry Gut and the valley south of Dry Gut would be shorter than to most other potential quarry sites;
- The open channel design has been modified to avoid the sensitive caves (Pryce, 2013) on the lower reaches of Bencoolen;
- The Dry Gut area is already highly modified and the added land take would be incrementally very small;
- The site is within the current work area, making it more readily accessible for monitoring; and finally
- It will provide a sufficient quantity of suitable fill at minimal additional impact, lowest cost and within the available ADAO and project time frame;
- Geotechnical surveys confirm that the open channel will be a viable source of fill material (will compensate for up to 90% of the shortfall) as well as providing stone suitable for concrete aggregate;
- The risk of differential settlement of the concrete culvert might have led to significant risks to the integrity of the fill below the runway, thus compromising the safety of the runway.

Main additional mitigation

It is proposed that the following mitigation measures will be implemented, in addition to those already specified in the Environmental Management Plan of 2011 (AECOM, 2011) and the Contractor's Environmental Management Plan (CEMP).

- The collection and relocation of rare endemic lichens to terraces in the open channel and/or slopes on higher elevation that fall outside of the construction footprint.
- Search and rescue surveys of viable endemic plant material for propagation and long-term storage will be carried out prior to and during construction.
- Search and rescue surveys for endemic invertebrate species and relocation to suitable habitats well outside of the construction footprint.
- The terracing of slopes will be as natural looking as possible, by combining features of rough surfaces and uneven slopes and benches to reduce the visual impact of the man-made water course.
- If feasible and practical, the open channel stream will make use of natural meandering features of erosion and sediment deposition zones.
- The channel has been designed to ensure low velocity flows (<2m/s) for a 1:100 year storm event and the inlet and outlet structures will be designed to minimise erosion under such flows.
- The removal of invasives (such as wild mango) from the valley to the south of Dry Gut will be carried out throughout the construction period to facilitate the establishment of endemic flora.
- The long-term monitoring of the open channel and surrounding habitat will include the assessment of the successful establishment of lichens, invertebrates and endemic and invasive vegetation.
- Spoiling areas for unsuitable fill material have been identified in 2 possible locations i.e. the valley to the east of Prosperous Bay Plain (known as Middle Fill) and the area upstream from Dry Gut fill.
- Dust suppression on the haul road and open channel bed will be carried out to lower the levels of dust generated on site.

Additional monitoring points will have to be positioned in and around the construction site to cover all receptors that may be affected by the new proposal.

All mitigation measures will be explored and expanded on in detail, with the aid of specialists with relevant experience, and will be incorporated in the CEMP in the form of site specific environmental management and rehabilitation plans. All proposed mitigation measures (e.g. the final inlet and outlet designs), protocols and procedures (e.g. species translocation, rehabilitation of disturbed areas) will be approved by the Project Management Unit (PMU) prior to approval and adoption, which is a standard procedure for this airport project.

The study concludes that the main impacts of the open channel proposal will be on invertebrates and lichens – rated by Pryce (2013) as **minor to moderate adverse** before mitigation is applied, but careful re-routing of the channel has ensured that the most sensitive areas will be avoided thus minimising the impact on the ecology to **minor adverse**. The open channel site will provide an opportunity for scientific research into the re-establishment of lichens and invertebrates, recreate an open watercourse and will greatly reduce the waste and carbon footprint of the airport site compared to the reference design.

The major benefit of this proposal is that it will provide most of the rock short fall for the Dry Gut fill from an area largely within the ADAB and certainly within the area of disturbance, without having to develop quarries elsewhere on the island.

In conclusion, having considered all possible options to solving Dry Gut drainage challenges while winning the required rock to adequately complete the airport RESA, the open channel proposal would have the least environmental impact and least time delays to the project caused by the shortfall of suitable material on PBP.

1. Introduction

AECOM undertook the Environmental Impact Assessment (EIA) for the St Helena Airport and its associated infrastructure and published the Environmental Statement (ES) in 2007. The 2007 ES assessed the environmental effects of a temporary[2] attenuation dam in upper Dry Gut and the culvert running through the Dry Gut Fill. The contractor, Basil Read, now proposes to make adjustments to the reference design consisting mainly of the removal of the temporary attenuation dam wall and the culvert and replacing them with an open channel drain dissecting the ridge on the southern slope of Dry Gut. This will result in the reduction of concrete works in Dry Gut and the increase in prime fill material with minimal hauling distance. The proposal will increase the footprint of construction work onto the southern ridge of Dry Gut as well as into the valley to the south of Dry Gut. However, the footprint will decrease in upper Dry Gut. The purpose of this report is to describe the environmental effects of the revised design (adverse and beneficial) and identify any additional mitigation measures to be implemented during the detailed design and construction.

2. Approach

This document will describe the environmental effects of the 2013 open channel drain proposal and compare these to the 2007 design of a temporary attenuation dam and culvert as assessed in the ES.

The approach of this Addendum is therefore to:

- Describe changes to the reference design that are relevant to this proposal;
- Describe existing environmental conditions in the extended ADA;
- Assess potential effects of changes to the reference design;
- Provide a list of additional mitigation measures that will be required;
- Provide a comparison and summary of effects.

3. Scope of the Addendum

The scope of this addendum is to cover the 2007 ES topics which are directly related to the changes that the open channel proposal (2013) poses to the reference design (2007). Based on the screening opinion received from the St Helena Planning Division, the main environmental impacts will be on, but are not limited to, the biodiversity (namely invertebrates) of the affected area in the new proposal, including those outside of the current ADA.

The 2007 ES topics addressed in this addendum, as well as explanations for omitting the remaining topics, are presented in Table 3.1.

[2] Even though the attenuation dam that was assessed in the 2007 ES was a temporary structure, it would still have had a significant impact on land take both at the dam wall site and in the area of potential inundation. This in turn would have had an impact on Wirebird habitat, vegetation, flows in lower Dry Gut and aesthetics.

Table 3.1: ES topics covered in this assessment

ES Topics	Coverage in this addendum
Land Use	Effects of reduced land take in upper Dry Gut and increased land take in the valley to the south of Dry Gut
Noise and Vibration	Changes resulting from the increase in blasting and excavating in Dry Gut and the valley south to Dry Gut.
Air Quality and Dust	Changes resulting from the increase in blasting, excavation and hauling of material
Carbon Emissions	Changes resulting from the reduced use of concrete batching and crusher plant for the culvert and the reduced hauling distance of viable fill material
Terrestrial Ecology and Nature Conservation	Key issues covered are the footprint and land take on the valley to the south of Dry Gut (with regards to impacts on invertebrates and lichens) and reduced footprint in upper Dry Gut as well as the southern ridge of PBP and the implications for Wirebird habitat.
Landscape and Visual Amenity	Key issues covered are the works in the valley to the south of Dry Gut as well as the reduced works in upper Dry Gut
Geology and Hydrogeology	The geology and hydrogeology of the southern flank of Dry Gut and south-western end of the runway.
Surface Water	The introduction of an open watercourse as the diversion of surface water from Dry Gut into the valley to the south of Dry Gut, but no attenuation of flow in lower Dry Gut. Issues of in-channel erosion will be addressed.
Waste Management	Spoil material, concrete waste, construction rubble (attenuation dam) and empty cement bags
Archaeology and heritage	There are no features of archaeological or heritage interest in the area.
Traffic and footpaths	The proposed project will not affect any roads. The open channel may affect one footpath.
Buried ordnance	Not applicable.

Additionally, the Contractor's Environmental Management Plan (CEMP) will be updated based on the mitigation measures that have been identified in this Addendum. All proposed mitigation measures (e.g. the final inlet and outlet designs), protocols and procedures (e.g. species translocation, rehabilitation of disturbed areas) will be approved by the Project Management Unit (PMU) prior to approval and adoption, which is a standard procedure for this airport project.

4. Changes to Scheme Design

4.1 Introduction

The original reference design proposed that two closed culverts be constructed underneath the Dry Gut fill to convey any runoff from the Dry Gut catchment and the south-western portions of the airfield footprint. One culvert was proposed for operation and the other to serve as a backup in the case of an emergency and to provide safe access for any maintenance requirements. At tender stage, Basil Read (BR) proposed that the above system be replaced by a single culvert coupled with an attenuation dam upstream of the culvert in Dry Gut.

During the design stage a number of alignment options were investigated for the culvert, but significant risks were associated with them all, relating primarily to the risk of culvert subsidence (Worley Parsons, 2013).

The second problem that has arisen is the need to spoil larger volumes of unsuitable fill material than originally anticipated from the runway site, with the corollary that there is now a shortage of suitable rock fill for the runway extension over Dry Gut. Calculating the volumes of bulk earthworks and balancing the cut to fill volumes is of vital importance to the overall construction programme of the project. Coupled with this is the importance of finalising the runway vertical alignment and associated levels for the airport buildings in order that foundations for these structures may commence with total confidence.

Thus a solution needed to be found to address the following two issues: drainage of storm water from Dry Gut away from the toe of the rockfill; and a source of suitable rockfill material. The option of constructing an open diversion drainage channel on the southern side of Dry Gut provides a sound engineering solution to solve both these problems.

The comparison of the reference design to the open channel proposal is described in the table below.

Table 4.1: Design and construction elements of 2007 reference design and 2013 open channel proposal considered in this EIA Addendum

2007 reference design: design and construction elements	**2013 proposal: design and construction elements**
Dry Gut Concrete Culvert	Open Channel
Dry Gut Temporary Attenuation Dam Wall	Open Channel Haul/Maintenance Road
Culvert Haul/ Maintenance Road	-
Dry Gut Fill quarry site outside of ADA/ADAO	-

4.2 ADA

2007 Reference design

Several changes to the airport and other infrastructure components were made to the ADAB (2007) in 2011 (2011 ES Addendum, Vol. 7, page 4 section 2.2.). Within Prosperous Bay Plain (PBP), the change to the 2007 ADAB that is most relevant to the open channel proposal is that to the south of the runway, in Dry Gut, the

boundary was moved northwards (comparison of 2007 ADAB and 2011 ADAB: Figures 1 and 2 in 2011 ES Addendum, Vol. 7).

2013 Open Channel Proposal

Two sections of the new proposal for an open channel fall outside the current ADA (2011): an area of 0.23 ha on the north-east corner and an area measuring 1.1 ha on the south-west corner (Figure 4.1 and Appendix C). An additional area of 0.37 ha will be necessary for the construction of the required maintenance road (Figure 4.1), thus bringing the total land take outside of the ADA to 1.7ha.

The Airport Development Ordinance is described in detail in Chapter 4 of the ES (2007), but it is worth noting the following.

The Airport Development Ordinance came into force in September 2006 and makes provisions to facilitate the design, construction and operation of an airport on St Helena. Under Sections 4 and 5 power is given (subject to safeguards) to designate any land as an Airport Development Area (ADA).

The effect of this, under the subsequent provisions of the Ordinance, is to enable the Governor to grant exemptions from certain existing laws. The Ordinance states that nothing done in an ADA with the consent of the Governor in Council shall be held to be in contravention of the Land Planning and Development Control Ordinance.

In a later development, an Airport Development Order Area (ADOA) has been delineated. The proposed open channel lies within the designated ADOA, which means that the streamlined process set out in the Airport Development Ordinance applies here, and the standard procedure of submitting a planning application will be followed.

4.3 Open Channel

2007 Reference design

At tender stage, Basil Read (BR) proposed that the initial reference design of two culverts be replaced by a single culvert coupled with a temporary attenuation dam upstream of the culvert in Dry Gut. The box culvert would have been positioned in the centre of the valley, on the stream bed and starting at invert level 215m. The 2007 design also included a 15m high dam wall with the storage capacity of 100,000 cubic metres in upper Dry Gut. The aim of the temporary dam was to protect the bulk fill from stormwater runoff during construction of the culvert. The dam would have been removed once the culvert was in place.

During the design stage a number of alignment options were investigated for the culvert, but significant risks were associated with them all, relating primarily to the risk of culvert subsidence (Worley Parsons, 2013).

2013 Open Channel Proposal

The purpose of the open channel drain is to adequately convey storm water runoff generated from the upper Dry Gut catchment, and the storm water runoff from the southern portion of the airfield footprint and the terraced embankments of the Dry Gut fill into the neighbouring valley immediately south of the Dry Gut. It should be noted here that flows in Dry Gut valley are ephemeral (short-lived) and very infrequent, but the design specifications require the drainage channel to accommodate the 1:100 year flood.

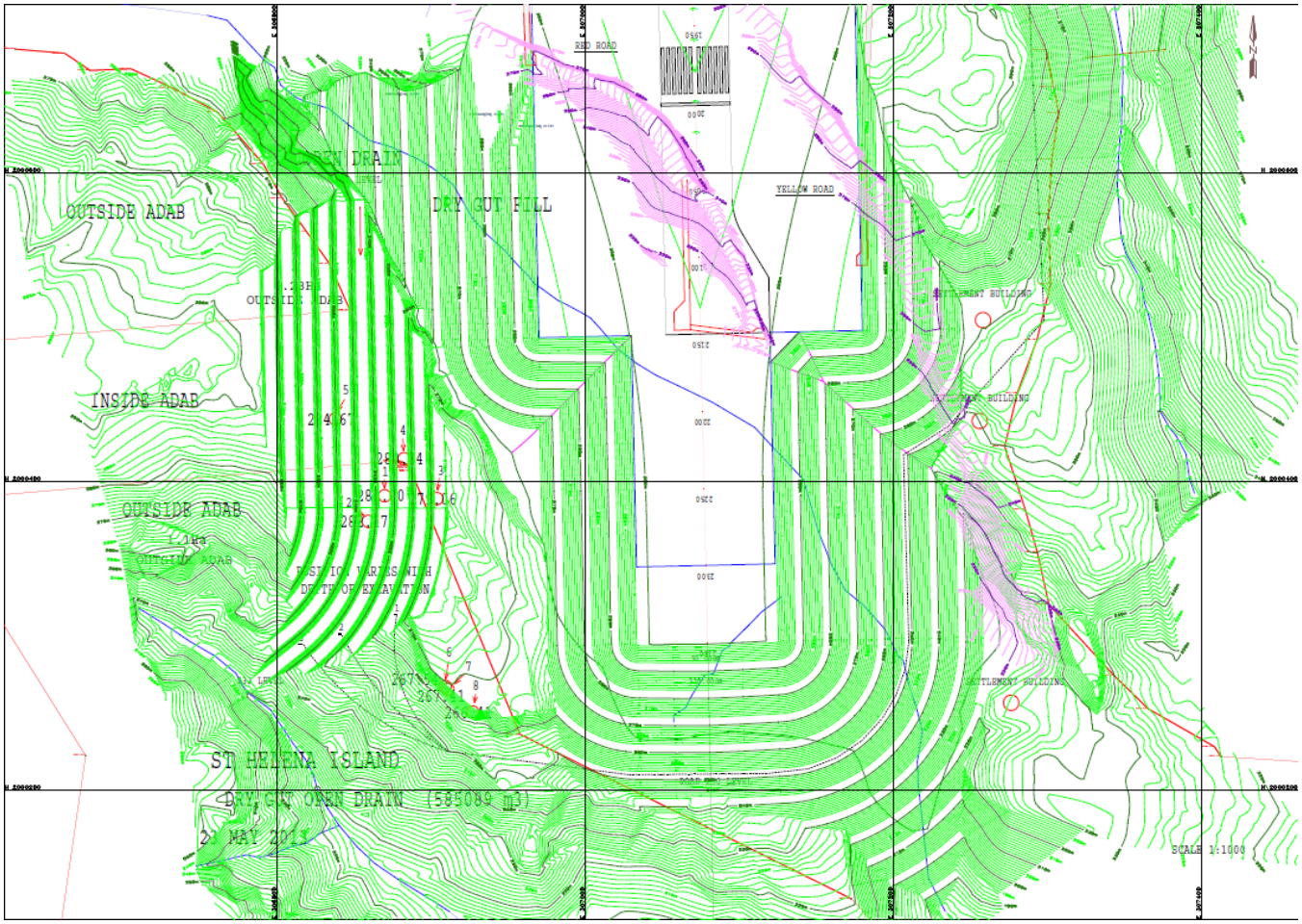

Fig 4.1: Dry Gut Open Channel proposal indicating ADAB (red lines)

The open channel is to comply with the following design criteria:

- Minimum 4 m wide channel base suitable for vehicle access for maintenance (Employer's Requirements);
- To convey the 1 in 100 year storm flows from the Dry Gut catchment, together with storm water flows from the southern portion of the airfield footprint;
- To provide suitable energy dissipaters at the channel outlet to spread the storm flows down the natural gullies of the valley sides to the neighbouring valley; and
- To provide erosion protection measures in the form of a rock face or concrete berm at the inlet of the open channel to protect the toe of the main Dry Gut fill from erosion (Worley Parsons, 2013).

The modelled maximum flood peak for a 1:100 year storm event at the lower end of upper Dry Gut has been calculated as being 31.3 m^3/s, which when combined with runoff from the airfield footprint (6.9 m^3/s), adds up to a possible peak flow entering the channel of 38.2 m^3/s. The slope and alignment of the channel will be designed to ensure velocities in the range of 1 - 2 m/s and the flow regime along the open channel will as far as

possible stay in the sub critical zone. The open channel will be cut into the southern face of the Dry Gut and will maintain a relatively constant grade of maximum 0.05% over the length of the channel to maintain the design flow velocities. The total length of the open channel will be approximately 391 m (Worley Parsons, 2013). Figure 4.2 indicates the typical geometry and dimensions of the open channel.

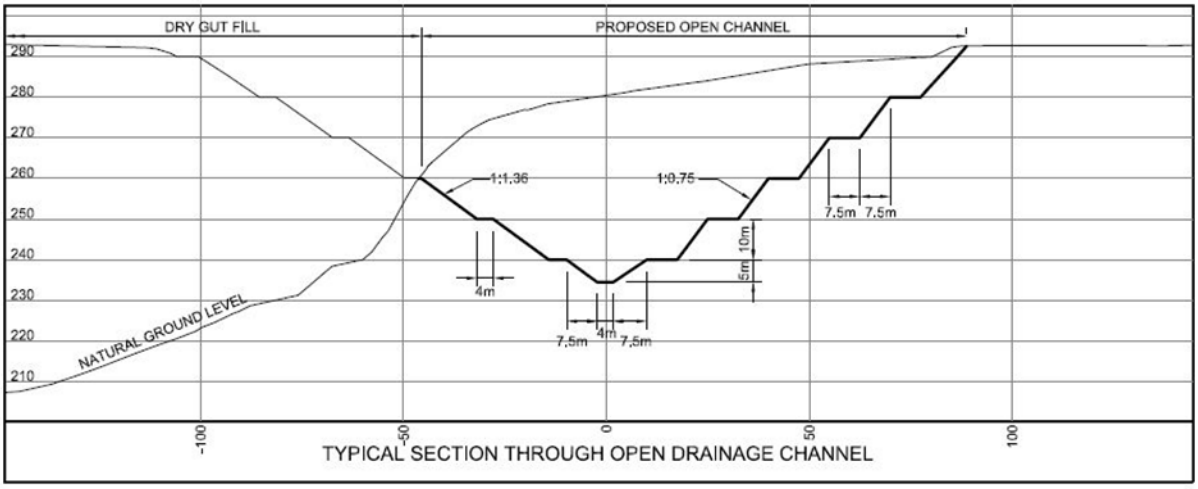

Figure 4.2: Typical section through the open channel

Four different route alignments were considered, as shown in Figure 4.3. Route A was the originally proposed route and was found to have a significant adverse environmental impact due to the presence of a large portion of the world's population of an endemic species of lichen, *Roccella sanctae-helenae,* in an area of unnamed cliffs and caves on the lower slopes of Bencoolen (alignment A of Pryce's survey report, Appendix B). Route B (Alignment B of Pryce's report, Appendix B) was proposed to avoid this location, but it was feared that this route could cause a loss of seepage to the aforementioned damp caves and thus it could have an indirect effect on the lichens. This route is also much closer to the fill, and blasting in this area could cause stability problems in the fill.

Route D avoids the sensitive area around the lower reaches of Bencoolen and the outlets are further up the valley to the south of Dry Gut than either Routes A and B. Therefore, the channel alignment Route D, has been selected by the contractor as the preferred route and it is significantly shorter (approx. 50m difference in length between Routes A and D) than the other three.

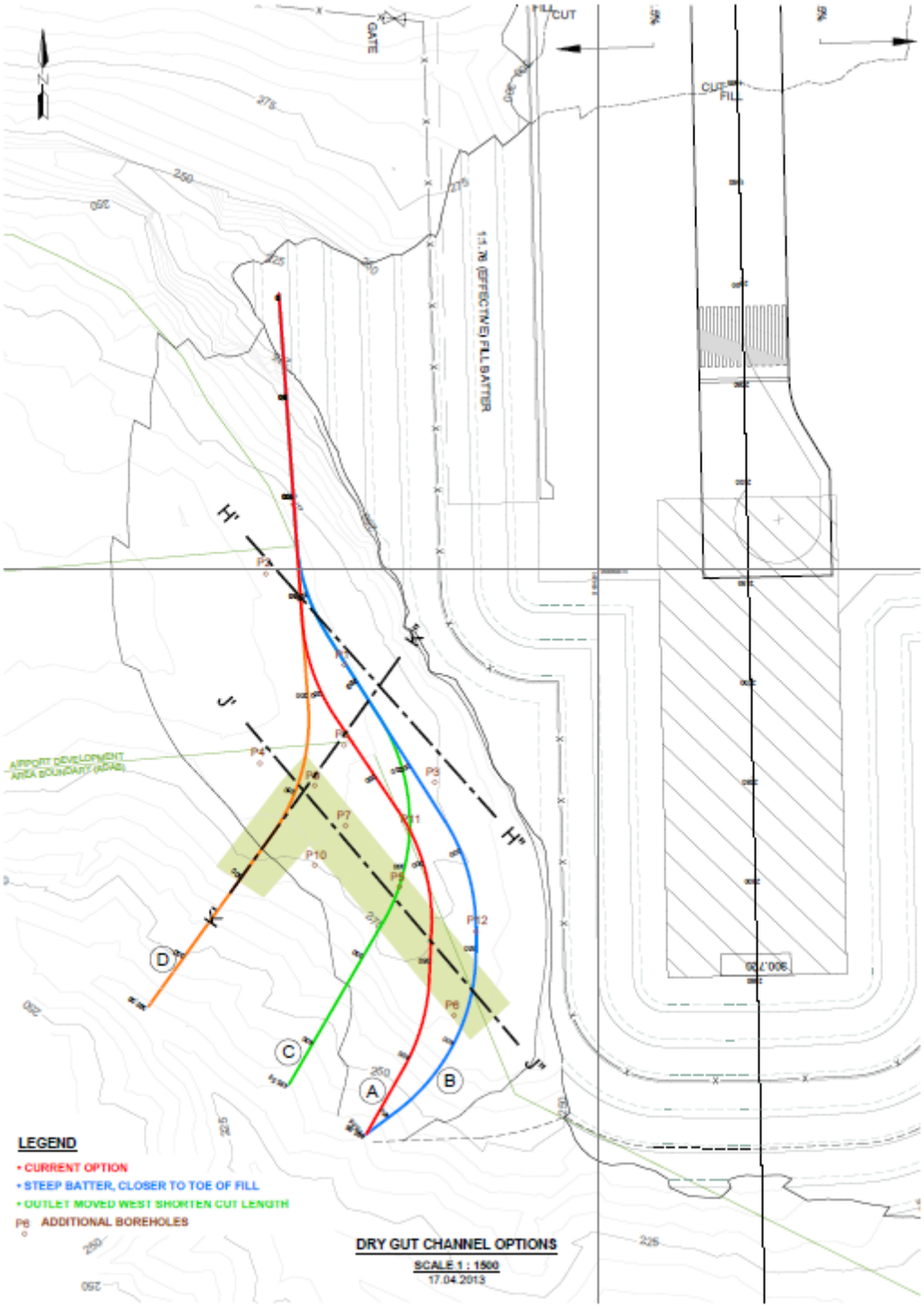

Fig 4.3: Different open channel alignments considered (A, B, C, D)

4.4 Earthworks

2007 Reference design

The earthworks activities associated with the reference design (2007) involved the following:

- Drilling and blasting a key[3] for the attenuation dam wall;
- The construction of a haul and maintenance road to the Dry Gut culvert;
- Quarrying outside the ADA for suitable material for the Dry Gut fill and crusher run. This was necessitated because geotechnical surveys conducted in February 2013, indicated that the volumes of suitable material from the runway alignment would not meet the technical specifications for the Dry Gut fill nor meet the standards for the aggregate needed to construct the concrete dam and culvert;
- Hauling of suitable material from the runway and/or quarry to Dry Gut or the crusher;
- Hauling of unsuitable fill material to designated spoil areas.

These activities will no longer take place under the open channel proposal.

2013 Open Channel Proposal

The earthworks component of the works associated with the open channel (2013) consists of drilling, blasting, excavating and hauling of material from the haul/ maintenance road as well as the open channel cut. The work will be carried out by 2 teams of 10 ADTs and 2 excavators for day and night shifts, 6 days a week. The total amount of suitable material to be hauled will be 720,000 m^3 over a period of approximately 100 days. This translates into 48,000 truck loads. Approximately 10% of the total cut of the channel is predicted to consist of unsuitable material which will have to be spoiled in either of the two designated spoil areas i.e. upstream from Dry Gut fill or the valley to the east of Prosperous Bay Plain (known as Middle Fill).

4.5 Haul and Maintenance Road for Open Channel

2007 Reference design

Although the reference design (2007) states that an access road for maintenance is a requirement of the contractor, this was never accompanied by a design or an alignment.

2013 Open Channel Proposal

The haul road for the new proposal (2013) will run from the fill level (250m contour line) to the open channel cut entrance (235m contour line) and will be approximately 700m in length and varying in width from 4m as it traverses Dry Gut fill, to 13m at the entrance to the open channel. Once the earthworks component of the open channel has been completed, the final maintenance road alignment (haul road alignment 3) will be determined and those road sections which will no longer be needed (alignments 1 and 2), will be rehabilitated (Figure 4.1).

One of the Employer's Requirements is for a 4m wide road base to allow vehicle access for maintenance purposes. An access road will also be required to perform regular monitoring of the rehabilitated areas in the open channel. There are two possible routes for this access track:

[3] The dam wall must be connected to firm rock at either end of the wall and along the base to prevent water from seeping through. This connection area is called the **key**.

- From a point upstream in Dry Gut, up the south flank of Bencoolen to the works area (northern access route) (see site plan in Appendix C);
- From the south-east corner of the airfield, following the 250m bench in the bulk fill and thereafter following the haul road route to the open channel area (southern route) (Figure 4.1 and site plan in Appendix C).

The latter (southern option) is preferred as this will have a far smaller footprint, require less earthworks and it remains in the proposed new ADA (Figure 4.1). The northern route would require separate development permission, as it falls outside the ADA and may have a significant impact on the environment.

4.6 Inlet and outlet of open channel

2007 reference design

A concrete head and wing wall structure with a distilling basin at the outlet (if required) is structural practice with a culvert design.

2013 Open Channel Proposal

These structures will be designed to prevent erosion under a 1:100 flood event. The designs will be finalised in consultation with the environmental coordinator and ecological experts.

5. Description, Assessment and Comparison

5.1. Land Use

2007 Reference design

In the 2007 ES the valley to the south of Dry Gut has no official land use and it is described as rough ground, composed of rocky hill slopes and is not listed as an area of ecological constraint (Figure 9.1 of Vol. 3, 2007 ES). However, the area in upper Dry Gut, reserved for the attenuation dam, is a known Wirebird territory and is an area regularly surveyed by the Wirebird Conservation Team.

2013 Open Channel Proposal

The key design changes affecting land use as a result of the proposed changes to the reference design are:

- The increase in footprint (outside of ADA 2011) of 1.7 ha on the southern side of Dry Gut and northern slope of the valley to the south of Dry Gut;
- The reduced footprint of 2.8 ha in upper Dry Gut. This is the area that would have been affected by the temporary attenuation dam wall and associated inundation area;
- The addition of a haul/maintenance road on the northern slope of the valley to the south of Dry Gut with a length of 700m.

Given the sensitivity of the local area and the magnitude of the impacts associated with the proposed works it is anticipated that the open channel will have a permanent **moderate adverse** impact on land use before mitigation.

To address the anticipated land use impacts from the proposal, the area affected by the works will be designed to allow effective rehabilitation. Invertebrate and endemic vegetation specialists will be consulted to inform the design and guide the implementation of this rehabilitation.

The implementation of the proposed mitigation measures will reduce the residual effect to a permanent **minor adverse** impact on land use. Table 5.1 summarises the comparison and effects on land use.

Table 5.1 Land use: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effects without mitigation	Additional mitigation required	Residual effect from 2013 proposed open channel
Bencoolen and Dry Gut	2007 ES Significance: **Not assessed**	Temporary haul road from Dry Gut fill to open channel outlet. Additional landtake for open channel and maintenance road.	Moderate adverse (permanent)	Rehabilitation of the parts of the haul road that fall outside the alignment of the maintenance road. Rehabilitation of open channel terraces.	**Minor adverse** (permanent)

5.2.Noise and Vibration

2007 Reference design

The reference design required the construction of a temporary attenuation dam which would have required blasting and earthworks activities at the dam wall abutments, as well as during the sourcing and transportation of rock to form the core of the dam wall. The noise and vibration associated with these activities would have been felt by the residents of Woody Ridge and possibly, Levelwood. The initial assessment (2007 ES) rated the impact after mitigation to be **minor adverse** for the duration of construction.

2013 Open Channel Proposal

While more blasting will be required for the open channel than for the dam wall, the location of the activities is further away from residential areas and there will be some topographic screening of the noise as well. On balance the impact without mitigation could increase (from the reference design) to **moderate adverse** for the entire construction period of 4 months.

In order to mitigate the noise and vibration impacts, blasting will not take place over weekends or at night, and where possible, blasts will be confined to small sections at a time to achieve the terraced landform envisaged in the design. Most of the blasting will take place over a 3 month period. Noise and vibration associated with the

movement of haul trucks to and from the open channel quarry will not add further to the current impact of earthworks in the Dry Gut fill and runway sites. Noise and vibration monitoring will be conducted before and during blasts. All other mitigation measures specified in the 2011 EMP will be applied where relevant to minimise noise impacts.

There is a high degree of confidence that these mitigation measures can be effective in reducing the noise impacts and therefore the post-mitigation assessment is rated as temporary **minor adverse**.

Table 5.2: Noise and vibration: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effects without mitigation	Additional mitigation required	Residual effect from 2013 proposed open channel
Bencoolen and Dry Gut	Minor adverse (construction only)	Increased blasting and excavating in Bencoolen area Reduced works in upper Dry Gut	Moderate adverse (construction only)	Additional monitoring points; Blast design and blasting schedule	**Minor adverse** (construction only)

5.3. Air Quality and Dust

2007 Reference design

The construction of the temporary attenuation dam would have required rock drilling, blasting, transportation of rock, grubbing and clearing of the dam basin, all of which have the potential to cause dust in the arid area in which they were to take place (upper Dry Gut). The nearest residential area of Woody Ridge is some 3 km away and so the dust impact would not have been too significant for the residents, but the fall out of dust onto the vegetation and micro-habitats of upper Dry Gut would have been severe, as reflected in the 2007 ES assessment of **very large adverse to large adverse** (see Table 5.3).

2013 Open Channel Proposal

As with the noise impacts, the activities associated with the construction of the open channel will be further away from residential areas, but the dust impact on fauna (especially invertebrates) and flora during construction will still be very **large adverse** in the Bencoolen area.

As far as possible, dust will be minimised using water bowsers on the haul and maintenance roads as well as along the open channel stream bed during construction. The plants and soils in the areas adjacent to the construction works will be monitored for a build up of dust.

Re-vegetation of exposed/ disturbed surfaces, such as the open channel terraces and the decommissioned haul road(s), will take place immediately after construction to stabilise loose surface soils. However, it should be

noted that the channel will be cut into solid rock and re-vegetation in certain places will not be possible. Furthermore, the area lies in the EAA and so the re-establishment of plants, even with a re-vegetation programme will be a long process. Thus the mitigation will only have a slight effect on the total dust emissions and therefore the impact rating after mitigation will be **very significant to major adverse** during construction (Table 5.3). Once construction ceases, the impact may be **minor adverse** until the area of disturbance is stabilised. The area will continue to be monitored for dust and the re-vegetation areas will also be monitored and maintained.

Table 5.3: Dust and air quality: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effects without mitigation	Additional mitigation required	Residual effect from 2013 proposed open channel
Bencoolen	Very significant to major adverse (construction only)	Increase in dust emissions from excavating and blasting for open channel and haul/maintenance road	Very significant adverse (construction only) Moderate adverse (permanent)	Dust suppression on road and open channel Additional monitoring points for new receptors (TSP only as no human receptors)	**Very significant to major adverse** (construction only) **Minor adverse** (permanent)
Dry Gut	Very large adverse to large adverse (construction only)	No additional dust emissions from crusher and batching plant because no need for concrete culverts	No additional impact	None	**No additional impact**

5.4. Carbon Emissions

2007 Reference design

The reference design required two concrete culverts, measuring 3.6 m high, by 3.8 m wide and 720 m long (reference design 2007, drawing number 5098141-Cl-01-1071) to be installed under the Dry Gut fill to convey any possible storm water from upper Dry Gut and the south-western parts of the runway to lower Dry Gut without affecting the integrity of the fill. This would have required 3,312 tonnes of cement, 8,000 tonnes of crusher run and 2,023,500 litres[4] of fresh water (desalinated/ suitable groundwater/ island's water system) to

[4] [4] Calculated on the basis of 213 litres of water per cubic metre of concrete produced

produce 9,500 cubic metres of concrete (1,000 spinner trucks). In addition, 535 tonnes of rebar were required to reinforce the concrete. While the water and crusher run would have been sourced on the island, the cement and rebar would have been imported via ship from Walvis Bay and transported to site along the new haul road from Rupert's Bay. Unfortunately, by the time the decision to change the reference design was made, much of the rebar had already been imported.

The reference design also required that most of middle Dry Gut valley must be filled to accommodate the Runway End Safety Area (RESA) and this requires a certain amount of rockfill of a specific quality. This was expected to be sourced from the runway area, but contrary to Atkins' initial findings, the quality of rock along the runway alignment was much poorer than expected and unsuitable as bulk fill material. Therefore the shortfall of 800,000 m^3 has to be found elsewhere and hauled to the fill area.

The impact rating in the 2007 ES for carbon emissions for the Dry Gut culvert reference design was **minor adverse.**

2013 Open Channel Proposal

Since the open channel proposal does not call for any concrete, there are real savings to be obtained in terms of the carbon emissions which would have been generated by the manufacture and transportation of the cement, the hauling distances from Rupert's Bay and the diesel costs associated with the operation of the concrete batching plant and the movement of concrete trucks from the batching plant to the culvert site (as shown in Table 5.4 below).

The open channel construction will still require haul trucks to convey the excavated rock to the Dry Gut fill, but the distance involved will be less than from the runway, or from any other potential quarry site, thus there will be some further savings. The total saving in carbon is estimated to be approximately 875 metric tonnes.

Overall, the reduction of carbon emissions will result in a **minor beneficial** impact (Table 5.5).

Table 5.4: Comparison between the reference design and the open channel proposal with regard to carbon emissions

Design option	Activities	Diesel demand	Carbon emissions
AECOM reference design	Cement manufacturing and shipment : 3,312 tonnes of cement to be shipped (Shipment of rebar 535 tonnes)	5 voyages for shipment of cement, fly ash, diesel and rebar at 30 000l per voyage. Total: 150,000 litres	352 metric tonnes
	Batching: 9,500 m^3 of concrete to be batched	200l diesel a day for 3 months. Total: 24,000l	0.47 metric tonnes
	Crushing: 8,000 tonnes of crushed material required	2,400l diesel a day for 3 months. Total: 288,000l	5.6 metric tonnes
	Hauling 800,000 $m^3$of suitable material from runway to fill	Runway to fill: 8l diesel per trip. Total: 320,000l	Runway to fill: 752 metric tonnes

Open channel proposal	Reduced hauling distance from open channel to Dry Gut fill and spoil area (700m) compared to hauling from runway to Dry Gut fill (2km) 48,000 trips to haul 720,000 m^3 of material from channel excavation to fill	Open channel to Fill: 2.5l per trip. Total: 100,000l	Open channel to Dry Gut Fill: 235 metric tonnes

Table 5.5: Carbon emissions: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effects before mitigation	Additional mitigation required	Residual effect from 2013 proposed open channel
Bencoolen and Dry Gut	Minor adverse (construction only)	Increased traffic on Bencoolen. No need to fabricate concrete culverts and therefore carbon savings in cement production and transportation. Savings of 42,000l in fuel usage at batch plant and crusher. Reduced hauling distance of rock fill material from another quarry site compared with open channel option	Minor adverse (construction only)	None	**Minor adverse** (construction only)

5.5. Terrestrial Ecology and Nature Conservation

2007 Reference design

The reference design required the construction of a temporary attenuation dam at the lower end of upper Dry Gut valley to prevent stormwater flows from entering the middle Dry Gut bulk fill area during culvert

construction. The attenuation dam would have been a rockfill structure across the valley with a dam basin large enough to accommodate a 1:100 year flood (an area of 2.8 ha). According to Figure 9.1 (Vol. 3 of 2007 ES), this area would have impinged on a key Wirebird territory (**moderate adverse** impact) and abutted an area proposed as a National Protected Area (**minor adverse** impact).

2013 Open Channel Proposal

The key design changes affecting terrestrial ecology (primarily invertebrates, lichens, vegetation and avifauna) and nature conservation are:

- The increase in footprint on the southern side of Dry Gut and northern slope of the valley to the south of Dry Gut - 1.7 ha outside of ADAB;
- The reduced footprint in upper Dry Gut (removal of attenuation dam 2.8 ha) and therefore no impact on proposed National Protected Area;
- The addition of a haul/maintenance road on the northern slope of the valley to the south of Dry Gut (approximately 700m from Dry Gut Fill to outlet of open channel;
- A very slight increase in surface water flow in the valley to the south of Dry Gut;
- No attenuation of flow to lower Dry Gut during the construction period (which would have been caused by the presence of the temporary dam).

The baseline description for each key ecological group, impact statements and proposed mitigation measures are provided in the sub-sections below.

5.5.1. Invertebrates

2007 Reference design

Several invertebrate surveys were carried out on PBP by the Belgians[5] in the 1960s (see Basilewsky references in the Pryce report in Appendix B) and more recently by the Ashmoles in 2004. These surveys showed that 51 endemic invertebrates were present in the EAA (Eastern Arid Area), 35-40 occur in PBP and at least 20 of these are considered to be endemic to the plain itself. Of the 22 sampling sites (Ashmoles 2004) in the EAA, none of these were located in the valley to the south of Dry Gut or in upper Dry Gut (ES 2007 Vol. 3 Figure 9.4.).

2013 Open Channel Proposal

For the open channel proposal (2013), an invertebrate baseline survey was required for the area affected i.e. the lower reaches of Bencoolen and the valley to the south of Dry Gut. The survey would assist in determining any significant impacts of the proposal on the invertebrate populations and habitat in the affected area. An invertebrate survey was commissioned by the contractor, Basil Read, and was conducted by the invertebrate specialist David Pryce from 26 April 2013 to 20 May 2013 (Appendix B). The surveyed area covered the entire area of the proposed open channel, including the various route options considered (Routes A, B, C and D), as shown in Figure 3 of Appendix B).

[5] Two expeditions by Belgian entomologists took place in the 1960s, each comprising three experienced zoologists, who spent periods between 8 November 1965 to 23 January 1966 and 21 January to 4 June 1967 on the island. During this period a variety of collecting techniques were used to obtain an assemblage of 100,000 invertebrates.

This survey took place over a three week period and is therefore a snapshot of the species found at that time of year. It should be noted that the period leading up to and through the duration of the survey had been unusually dry with drought conditions in portions of the island. It is impossible to say for certain how this will have affected the survey, but it is probable that tougher, more drought tolerant species will be over-represented and opportunistic species that feed on the grass that grows after the winter rains will be under-represented. The analysis of sampling effectiveness contained in s. 3.3 of Pryce's report (Appendix B) found that the area is under-sampled and that it is likely that more invertebrates would be present in the area depending on the season, antecedent rainfall and sampling effort (Pryce 2013).

Another key factor to note is that this is one of the most highly surveyed portions of the island as a result of the airport development. It is possible that species are more widespread away from the area but as relatively little survey work has been undertaken elsewhere, our knowledge of their wider distributions is not as clear (Pryce 2013).

The surveyed area of the lower reaches of Bencoolen is barren in appearance but holds a diverse invertebrate fauna. A total of 73 species of invertebrates were recorded by Pryce during his baseline survey of the area most likely to be affected by the proposal as well as the surrounding areas (Appendix B).

A total of 315 invertebrates representing 50 species were recovered during the initial survey from twelve samples. During the extended survey a further 473 invertebrates were collected from an additional eight samples bringing the total number of species to 73. Of all the species identified twelve are endemic to St Helena with six of these belonging to endemic genera. A complete species list, including details of their known scarcity and the number of specimens recovered is presented in Appendix 3 of Pryce's report (Appendix B).

Of the 12 endemic species found, 10 may be affected by the plan. However, in Pryce's assessment of the impacts on the relevant species, only 2 might suffer impacts; they are the darkling beetle *Tarphiophasis leleupi* and the silverfish *Ctenolepisma sanctaehelenae* (Table 2 in Appendix B) both of which are found outside the area of the open channel proposal.

The darkling beetle *Tarphiophasis leleupi,* was described as being new to science by the Belgians who found it at four sites: Great Stone Top, Long Range Cow, Prosperous Bay Plain and Sandy Bay beach, with it being abundant in the latter two locations. This species is 5.5 – 6mm long and can be distinguished by having only four lines of punctuations on each elytron, close to the midline. The beetle is entirely black, though always covered with a grey muddy coating (Figure 5.1).

However, it now appears that the species is much scarcer on Prosperous Bay Plain than it was during the initial discovery in the 1960s when 2,600 specimens were collected; that is, the Ashmoles only recorded 5 specimens in 2004 and the Cairns-Wicks and Lambdon survey of 2012 found none.

In Pryce's study, 3 live and 9 dead specimens (the beetle is very robust and remains of dead specimens persist for long periods) of the beetle were recorded in the surveyed area covering the construction footprint as well as its surrounding areas. The darkling beetle is found within and outside the footprint of the open channel as well as in the rest of the Eastern Arid Area (EAA) e.g. at Great Stone Top. It is also found more widely at Long Range Cow and at Sandy Bay beach. Based on these findings, the impacts of the open channel on this specific species

would be **minor to moderate adverse** and permanent without mitigation measures being put in place (Table 2 in Appendix B).

Figure 5.1: Two adults of the scarce endemic darkling beetle *Tarphiophasis leleupi*

The endemic silverfish *Ctenolepisma sanctaehelenae* was discovered by the Belgians and collected mainly on Prosperous Bay Plain, but also on Longwood Plain and Sandy Bay beach. This species grows to 13mm long, is whitish in colour and is not easy to distinguish from its introduced relatives on the island, but the presence of violet patches in various parts of the body indicates this species.

The silverfish was noticeably more common across this surveyed site than in the area to the north of Dry Gut surveyed in 2012 by Cairns-Wicks and Lambdon. It appears that this species is replaced by its non-native relative *C. longicaudata* in the valley to the south of Dry Gut. On this basis, the impact on this species was rated as permanent **minor to moderate adverse** without mitigation measures being implemented (Table 2 in Appendix B).

The Pryce 2013 invertebrate survey also found three known but undescribed species: one species of spider of the Oecobius genus, and two species of moth (Opogona genus). All of these species occur both inside and outside of the footprint, but their status in the EAA or elsewhere on the island is unknown. In this case it is recommended that the presence and status of these species outside the footprint area should be monitored closely.

Due to the increase in land take in the valley to the south of Dry Gut, additional mitigation measures will be implemented to reduce the potential adverse impacts on the invertebrates. These will include the following:

- A study to locate alternative suitable habitats for the beetle and silverfish. The populations of these species in these areas will be noted, along with other environmental factors e.g. plants, soil types, levels of disturbance, etc.

- Prior to the commencement of works, specialists will carry out a search for live specimens of the beetle and silverfish described above in the areas to be affected by construction (along with any other endemic species likely to be adversely affected by this proposal, especially the three undescribed species). These specimens will be relocated according to an agreed protocol to the previously identified habitats outside the construction footprint.
- The batters of the open channel will be left as rough and variable as possible for the creation of microhabitats as seen in the lower reaches of Bencoolen, in order to encourage surrounding invertebrate populations to enter this habitat.
- A long term invertebrate monitoring protocol and plan will be produced to monitor the outcomes of the implemented mitigation measures on existing invertebrate populations and introduced specimens from search and rescue activities. The plan will include adaptive management options if the monitoring indicates that the agreed methodology is not working.

From an ecological point of view, there are a number of ways of restoring an ephemeral stream habitat, such as:

- Shape the channel to form a meandering ephemeral stream;
- Create hollows of different depths to allow pools to form;
- Create overhangs and narrow sections to provide shade;
- Place rocks in the stream bed and allow natural sediment accretion to promote vegetation.

However, the Employer's requirements state that the channel bed must be a minimum width of 4 m to allow access for maintenance crews and monitoring teams. It is also not desirable to allow pools to form as these might attract flocks of birds which could pose a safety risk for aircraft. These requirements mean that none of the above habitat restoration measures would be possible. Further discussions are therefore required to find an acceptable solution to address safety concerns, maintenance requirements and ecological restoration needs.

If stream habitat restoration is possible, the overall impact on invertebrates could be reduced to a permanent **minor adverse** effect**.** If stream habitat cannot be restored for operational reasons, the impact will remain at permanent **minor to moderate adverse** (Table 5.6).

5.5.2. Lichens

2007 Reference design

The semi-desert habitats of PBP provide the main area of lichen interest on St Helena, they are often abundant and form the principal plants within vegetation communities. The area for the open channel was not surveyed for lichens during the specialist studies for the 2007 ES (Appendix 9-3, Vol. 4 of 2007 ES) and therefore the Pryce survey also included a baseline on the lichen communities within the area affected by the open channel proposal.

2013 Open Channel Proposal

The site within the lower reaches of Bencoolen is important for its lichen assemblage as at least four of St Helena's nine endemic species are present here and serve as the dominant vegetation for this area (Appendix B).

The site is especially significant for two of those species i.e. *Roccella sanctae-helenae* and *Dimelaena triseptata.* The latter occurs in great density and abundance on this site, in Dry Gut and on the southern ridge of Prosperous Bay Plain and occurs sporadically from the Barn to Great Stone Top (Figure 5.2).

Roccella sanctae-helenae on the other hand is found in great abundance on the lower reaches of Bencoolen unlike any other known site. A substantial population of this species is located sporadically on a few small outcrops on the northern side of the valley to the south of Dry Gut.

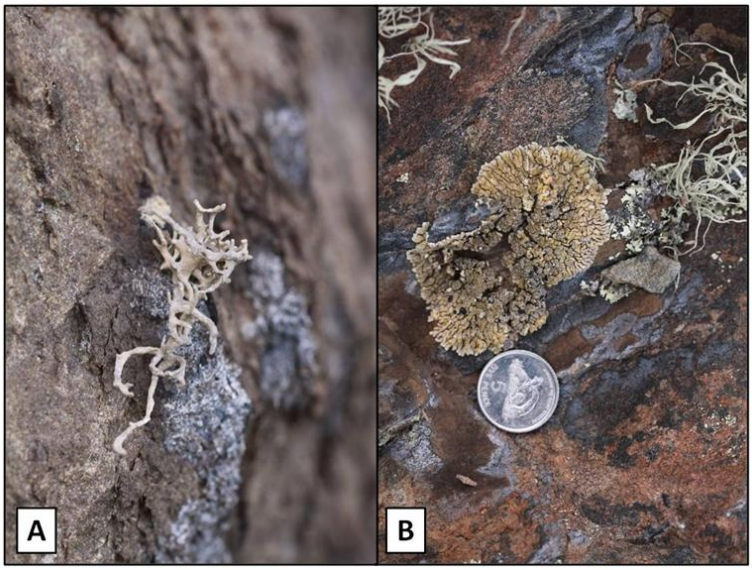

Figure 5.2: The two significant endemic lichen species found within the lower reaches of Bencoolen- (A) *Roccella sanctae-helenae* and (B) *Dimelaena triseptata.*

In his report, Pryce found that the proposed Route A would have a significant impact on the island's population of *Roccella sanctae-helenae*, giving rise to a **major adverse** permanent rating before mitigation. However, this species was not thought to be directly affected by Routes B, C or D and therefore there would be **no impact**.

Dimelaena triseptata on the other hand may be affected by all four channel alignment options, but because this species is more widespread on the island, the impact rating was given by Pryce as permanent **moderate adverse**.

In order to mitigate the impacts, the following recommendations are made based on Pryce (2013):

- Select the Route D alignment to avoid damage to the cliffs and caves on lower Bencoolen.
- Develop a search and translocation protocol for lichens in the affected areas in collaboration with a specialist.
- Identify suitable areas for storing rocks covered with *Dimelaena triseptata* before any removal activities.
- Prior to construction commencing, conduct a search for the rare lichen *Roccella sanctae-helenae* in the area below the cliffs and near the channel outlet. If found, a few of these specimens will be taken back to the caves and cliffs on lower Bencoolen and replaced by cementing the lichen and the rock that it came from onto currently lichen free areas.

- The flat terraces created during construction will be designed to provide suitable habitat for the recolonisation of *Dimelaena triseptata* in the long term.
- Loose stones and rocks with this species on them will be picked up by trained site staff (under the supervision of a specialist) and removed to areas previously identified outside the footprint for the duration of the works. These will then be available later to seed the upper terraces created during channel construction i.e. those terraces with a similar microclimate to the area where this lichen is currently found. This could be a unique opportunity for the long term-monitoring of a newly created 'habitat' as lichens colonise the area following completion of the project.
- Care will be taken during the construction and use of the haul/access road to the open channel site to minimise dust in this area, and its impact on the moist cave and cliff environments on the lower slopes of Bencoolen (see recommended dust mitigation measures in s. 5.3).
- A long term lichen monitoring protocol and plan will be produced to monitor the outcomes of the implemented mitigation measures on introduced specimens from search and rescue activities. The plan will include adaptive management options if the monitoring indicates that the agreed methodology is not working.

In applying the mitigation hierarchy (avoid, reduce, control, offset), the selection of Route D for the open channel avoids the direct (Route A) and indirect (Route B) significant impacts on *Roccella sanctae-helenae* in the caves of lower Bencoolen. Mitigation of impacts on the other important species of lichen, *Dimelaena triseptata*, through the relocation of rocks bearing this species to alternative sites is likely to be effective. Thus the impact rating for lichens after mitigation is reduced to temporary **minor adverse** (see Table 5.6).

5.5.3. Vegetation

2007 Reference design

The vegetation of upper Dry Gut (upstream from Dry Gut Fill) in the vicinity of the proposed attenuation dam wall and basin consists of a high to moderately weathered basalt with a layer of clayey silt, which has resulted in a thick layer of valuable topsoil on the valley floor. The dominant vegetation is Samphire which acts as a soil stabiliser. Endemic flora such as babies toes, bird grass and goosefoot are visible following periodic showers of rain on higher terraces. Invasive species such as wild mango, creeper and prickly pear are patchy but it was predicted in the 2007 ES that these species could spread with an increase of water in the area (Appendix 9-2 of Volume 4 of the 2007 ES).

This vegetation type would have been significantly affected by the attenuation dam (although it was not specifically assessed in the 2007 ES) – especially as habitat for the Wirebird (see s. 5.5.4 below), but will not be impacted by the proposed new design.

2013 Open Channel Proposal

The area to be affected by the proposed open channel is the south side of Dry Gut (i.e. the north facing slope), which was classified in the 2007 ES as being “steep rocky slope cliffs and crags”. The hillside is sparsely vegetated with brown rocky slopes, small to large boulder slabs (1m) and some fine orange sediment in between. In this area saltbush is the occasional but dominant species with patches of creeper and grass.

Endemic species such as Portulaca and boneseed are few and far between (Appendix 9-2 of Volume 4 of the 2007 ES).

This area will be significantly affected by the proposed open drain, but the incidence of endemic plants in the area is low and therefore the impact would be permanent **minor adverse**.

It is recommended that the following mitigation measures should be implemented:

- The alien invasive plant species, wild mango (*Schinus terebinthifolia*) in particular should be removed from Dry Gut and the valley to the south of Dry Gut to prevent possible blockages of the channel. Replace with native and endemic species.
- Implement an ongoing programme of invasive species management across the whole rehabilitated area.
- Adopt the existing protocol to search for and rescue endemic plants from the affected area for propagation/safe-keeping in a nursery and subsequent transplanting to rehabilitate the area.
- A long term vegetation monitoring protocol and plan will be produced to monitor the outcomes of the re-vegetation programme. The plan will include adaptive management options if the monitoring indicates that the agreed methodology is not working.

With the successful implementation of these mitigation measures, the impact on indigenous plants as a result of this project, given their low abundance in this area, will reduce to **negligible** (see Table 5.6). The removal of invasive plants on an ongoing basis will have a long-term **minor beneficial** effect.

5.5.4. Avifauna

2007 Reference design

The upper Dry Gut area is a known Wirebird (*Charadrius sanctaehelenae*) breeding site and is regularly monitored by both the Wirebird Conservation Team and the Basil Read environmental monitoring team. The floodplain and ephemeral stream that produces pools during favourable weather conditions is a prime site for Wirebird feeding and breeding (Appendix 9-2, Vol. 4 of 2007 ES). This habitat would have been significantly reduced with the presence of the attenuation dam (rated as permanent **moderate adverse**), but this impact will now fall away with the new proposal.

2013 Open Channel Proposal

The valley to the south of Dry Gut does not form part of a wirebird territory or mitigation area (Figure 9.6, Vol. 3, 2007 ES). However, during the survey conducted by Pryce in the valley to the south of Dry Gut, Madeiran storm petrels (*Oceanodroma castro*) were heard calling near the site. This species has been under threat for a number of years, but may be recovering, possibly due to the control of feral cats undertaken as part of the Wirebird Conservation Programme.

In terms of mitigation, no further mitigation of Wirebird habitat is required as the impact has been avoided, but the presence of Madeiran storm petrels should form part of the ongoing monitoring programme. The potential impact on these birds is **unknown**. If this species is found to be nesting within the zone of influence of the construction site, appropriate mitigation measures will have to be agreed with the PMU. These could include:

- Restrictions on certain types of construction activities during breeding season;
- Restrictions on night work and use of lights at night;
- Clearly designated 'no-go' zones to minimise disturbance.

Table 5.6: Terrestrial ecology: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	**Residual effect from 2007 reference design**	**Potential changes with 2013 Proposal**	**2013 effects without mitigation**	**Additional mitigation required**	**Residual effect from 2013 reference design**
Bencoolen and Dry Gut *Lichen*	Not assessed	-Increased footprint in Bencoolen area	Major adverse (permanent)	-Collection and relocation of *Dimelaena triseptata* to terraces; -Leave terraces as exposed bare rock to accommodate lichen attachment; -Search for and relocate any pieces of rock covered with *Roccella sanctae-helenae* -Ongoing monitoring	**Minor adverse** (temporary)
Invertebrates	Not assessed	-Increased footprint in Bencoolen area	Minor to moderate adverse (permanent)	-Identify areas to which rescued species can be relocated -Search and rescue endemic invertebrate species and relocate to suitable habitats well outside of construction footprint -Agree final	**Minor adverse** (permanent) (unless stream channel restoration not possible, then **minor to moderate adverse** (permanent))

				channel dimensions and final channel morphology to meet safety, maintenance and ecological needs -develop a long-term monitoring and evaluation plan including adaptive management options	
Endemic Vegetation	Not assessed	-Increased footprint in Bencoolen area	Minor adverse (permanent)	-Search and rescue endemic plants for propagation/safe-keeping in nursery and subsequent transplanting to rehabilitate the area -Ongoing monitoring	**Negligible**
Avifauna	Moderate adverse permanent (on wirebirds)	-Reduced footprint in Dry Gut -Increased footprint in Bencoolen area	None (wirebirds) Unknown (Madeiran storm petrels)	-Monitor the presence of Madeiran storm petrels	**Unknown** (Madeiran storm petrels)
Invasive Vegetation	Not assessed	-Increased potential for establishment of invasives in new channel and in the valley south of Dry Gut	Negligible	-Removal of wild mango from the valley to the south of Dry Gut; -Ongoing monitoring and removal	**Minor beneficial** (permanent)
Nature conservation	Minor adverse (temporary)	-No impact on proposed national Protected Area	None	-	**None**

5.6. Landscape and Visual Amenity

2007 Reference design

The landscape and visual amenity of Dry Gut and Bencoolen in the 2007 ES were described as areas with high scenic quality and value and with a lack of human influence. The visual effects on Dry Gut were the combined proposals of the fill, as well as the temporary attenuation dam and the impact rating was **minor adverse**. The residual effects on Bencoolen were relatively localised impacts caused by the nearby airport development and the installation of navigational aids.

Although the attenuation dam (2007 ES) would have been a temporary structure, it would still have required a significant amount of earthworks (abutments, rock fill, dam wall construction and land clearance), which would have had a negative effect on views from the Woody Ridge and Levelwood areas (rated in the 2007 ES as a temporary **major adverse** impact). Once the structure was removed, there would have been significant scarring of the landscape which would have taken some years to remediate. These impacts will no longer occur, thus reducing the overall visual impact of construction works from Woody Ridge and Levelwood.

2013 Open Channel Proposal

The key design changes affecting the landscape and visual amenity are:

- The excavation of the proposed open channel and removal of rock will have a major impact on the landscape;
- There will be greater visual impact from the Bencoolen footpath, but this walk is not used much;
- Visual impacts of the open channel will form a minor part of the much larger visual impact caused by the airport i.e. the additive visual impact will be very small (Figure 5.3);
- The landscaping and re-establishment of endemic vegetation and lichens found in Dry Gut and the valleys to the south of Dry Gut will provide a unique opportunity to monitor large-scale lichen re-establishment.

Fig 5.3: View of airport site from Great Stone Top overlooking lower reaches of Bencoolen

On balance the visual impact before mitigation in and around Bencoolen will increase slightly to **moderate adverse** compared to the reference design, but the visual impact in Dry Gut will improve from being a temporary major adverse impact to a permanent **minor adverse** effect.

In order to mitigate the impacts, the slopes of the open channel cut will be terraced, with exposed rock and left as rough and as natural looking as possible to promote the attachment of lichen, naturally or by introducing lichen covered rocks rescued prior to construction. Furthermore, a rough surface will provide the rock crevices and microhabitats suitable for endemic invertebrates. Re-vegetation will take place on the terraces and along the decommissioned sections of haul road. However, the new open channel will remain a scar on the landscape for some time. However the rock will eventually weather and the colour will darken and gradually blend into the landscape, but this will take decades. Thus the visual impact of the new works will change from being **moderate adverse to minor adverse** over time.

The visual impact for residents in Longwood and Woody Ridge will improve (without the temporary attenuation dam), but there will still be some residual permanent **minor adverse** effects resulting from the open channel works.

Table 5.7: Landscape and visual: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	**Residual effect from 2007 reference design**	**Potential effects of 2013 Proposal**	**2013 effects before mitigation**	**Additional mitigation required**	**Residual effect from 2013 reference design**
Bencoolen	Minor adverse (permanent)	-Visual impact limited to view from Bencoolen footpath – a walk that is not used much. -Visual impacts of the open channel will form a minor part of the much larger visual impact caused by the airport with natural exposed rock if mitigation executed correctly	Moderate adverse (permanent)	Landscape and ecological mitigation of open channel: -Terracing of slopes to be as natural looking as possible (rough surfaces, uneven slopes and benches); -Stream to make use of meandering features (erosion and deposition spots); -revegetation of lower slopes where possible with cliff species;	**Moderate adverse** changing to **minor adverse** over time

				-Lichen relocation on slopes of higher elevation; -Long term monitoring of newly created habitat (lichens, invertebrates, endemic vegetation, water quality and flow).	
Dry Gut	Major adverse (temporary)	Temporary dam wall removed. Reduced visual impact for residents in Woody Ridge and Levelwood areas.	Minor adverse (permanent)	None	**Minor adverse** (permanent)

5.7. Geology and Hydrogeology

2007 Reference design

The 2007 ES concluded that no measures would be needed to mitigate impacts associated with the geology and hydrogeology which may be affected by construction and operation of the airport project (2007 ES, Vol. 4, Appendix 13). The impact was therefore not assessed, even though the temporary attenuation dam would have interfered with natural groundwater seepage pathways and rates of infiltration.

2013 Open Channel Proposal

A geotechnical survey was commissioned by Basil Read and was conducted by Knight Hall Hendry (KHH) from 13 – 19 February 2013. The work entailed the drilling of 41 percussion boreholes in the vicinity of the runway and 7 percussion boreholes to the south of Dry Gut in the area for the proposed open channel. The survey concluded that the quality of the materials excavated from the runway area is highly variable, whereas the variation in material is much less in the area of the open channel proposal, with a much higher ratio of good material to waste. The new channel has been designed based on the geotechnical survey data to ensure that the benches and terraces on the sides of the channel will be stable.

One of the main impacts identified by Pryce (2013) was that the Route B channel alignment (Figure 4.3) could impact on groundwater seepage pathways, thus having an indirect effect on down-gradient sites where such seepage may daylight e.g. in the cliffs where the moisture-loving lichen *Roccella sanctae-helenae* was found. The unmitigated impact (Route B) would have had a major adverse permanent effect on groundwater flows.

Thus Route D, as described in s. 4.3 and shown in Figure 4.3 was chosen specifically to avoid the potential impact of Route B on groundwater infiltration and seepage pathways. The impact of Route D on groundwater seepage at the cliff location is considered to be significantly less and therefore rated as a **minor adverse** permanent impact.

The geotechnical report also recommends that the channel be positioned as far west as possible (i.e. route D) to minimise the amount of tuff (unsuitable fill material) that would have to be excavated.

Even with the alignment following route D, it is recommended that the seepage conditions in the sensitive caves on lower Bencoolen are monitored on a regular basis and compared to antecedent rainfall.

Table 5.8: Geology and hydrogeology: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effect without mitigation	Additional mitigation required	Residual effect from 2013 reference design
Bencoolen	Not assessed	Excavation of the open channel might affect groundwater flow patterns and pathways and impact on the moisture-loving lichens in the cliffs of lower Bencoolen	Major adverse (permanent) (Route B)	Visual monitoring of seeps in comparison to rainfall	**Minor adverse** (permanent) (Route D)
Dry Gut	Not assessed	No dam to interrupt surface water flows and groundwater infiltration	None	-	None

5.8. Surface Water

Dry Gut is rated as an ephemeral watercourse of high importance in the 2007 ES (ES Vol. 4, Appendix 15.1). The Dry Gut stream rises in Woody Ridge and flows eastwards for almost 5 km before discharging into the sea near Gill Point. The upper Dry Gut valley is broad, flanked by the low ridges of Woody Ridge to the north and Bencoolen to the south. A few short (< 1 km) water courses draining the ridges join the main stem, which is an ill-defined, narrow, sandy channel in a wide floodplain. This section is referred to as upper Dry Gut.

After about 3 km, the valley narrows considerably into a gorge and the nature of the channel changes to a narrow, well-defined rocky bed with waterfalls and plunge pools for a distance of about 500m. The valley widens out again for a short distance – this is the area that is being filled for the runway extension, and is referred to as middle Dry Gut. Just below the bulk fill area, the stream plunges over several high waterfalls to the sea; this reach is referred to as lower Dry Gut. Just before the Dry Gut stream enters the first of the lower Dry Gut waterfalls, it is joined by an unnamed short (less than 1.5 km), first order stream.

Although the Dry Gut catchment rises in an area with approximately 200 mm of rainfall per year, it quickly flows into the EAA, where annual precipitation is less than 100 mm. The entire catchment of the unnamed tributary lies in the EAA. As a result, flows in both valleys are ephemeral and infrequent. This is confirmed by the morphology of the main channel in upper Dry Gut which is poorly defined and overgrown in places. The tributaries in upper Dry Gut also show little sign of significant or frequent flows, however the waterfalls and pools hint at a wetter bygone era.

Water samples collected from pools in middle dry Gut during January 2012 showed that the water quality becomes increasingly saline and alkaline in a downstream direction.

2007 Reference design

The original proposal to construct a temporary 15m high dam wall to create a storage reservoir with the capacity of 100,000 m^3 in upper Dry Gut, would have prevented normal flow from reaching lower Dry Gut and thus cut off the transport of sediment/ nutrients downstream. In addition, in the event of water flow upstream of the dam, the area behind the dam wall would have been inundated, drowning the vegetation and all less mobile species of animals (2007 ES Vol. 4, Appendix 15.1, Table 15.5). Given the low frequency and ephemeral nature of flows in Dry Gut, the pool formed behind the dam wall would have slowly evaporated, leaving a salt crust on the soil surface, thus preventing the re-colonisation of native species. This process was evident in the pools in middle Dry Gut during the site inspection in January 2012, when small rock pools surrounded by an evaporative salt crust were observed. Furthermore, the Dry Gut closed culvert would have replaced the natural open watercourse over a distance of 770m. The impact was rated in the 2007 ES as **minor adverse**, but the consultants had not considered the downstream impacts on water flow.

2013 Open Channel Proposal

The attenuation dam and closed culvert system is being replaced with the open channel proposal, as described in section 4 of this Addendum.

The key design changes affecting surface water resources are:

- Flows over the waterfalls in lower Dry Gut (below the bulk fill) and along lower Dry Gut valley will continue to flow normally. Under the reference design, the temporary attenuation dam would have had a significant, albeit short-term, impact on downstream flows and the fauna and flora associated with the stream;
- Surface water flows in Dry Gut will continue to occur in an open channel (compared to a closed culvert), thus providing a resource and habitat to all forms of fauna and flora along its entire length;

- The open channel will discharge into a valley south of Dry Gut, which currently experiences flow on very rare occasions. This may change the characteristics of the channel in the unnamed valley over a distance of 700m but given the very low volume and frequency of flows, the impact will be negligible.
- The open channel has been designed to ensure that maximum flows will not exceed 2 m/s in order to prevent erosion of the channel. It should be noted however, that the channel will be cut into solid rock and therefore in-channel erosion is unlikely. The outlet into the valley south of Dry Gut will be designed to ensure that the 1:100 year flows are dissipated prior to discharge.

These changes are viewed as being an improvement on the reference design and will have far less impact on the water flows and associated aquatic habitats in Dry Gut. Thus the impact of the new design is assessed as **negligible**, both before and after mitigation.

Channelling the water via an open, rocky channel to bypass the bulk fill area is unlikely to have a negative impact on water quality. The pollution control measures relating to stormwater runoff from the runway area are dealt with in the EMP, 2011 and in the Employer's requirements for construction and operation and will not be addressed further in this Addendum.

Although the proposed open channel will have far less impact on the surface water resources of Dry Gut, it will still be necessary to observe water flows in the channel (when they occur) and to regularly check the new channel and the section of channel in the valley south of Dry Gut for sediment accumulation and erosion.

Table 5.9: Surface water: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	Residual effect from 2007 reference design	Potential changes with 2013 Proposal	2013 effects without mitigation	Additional mitigation required	Residual effect from 2013 reference design
Bencoolen	Not assessed	Minor increase in ephemeral flows in the valley to the south of Dry Gut, thus increasing water availability and improving habitat diversity	Negligible (permanent)	Water flow observations	**Negligible** (permanent)
	Not assessed	Water will continue to flow in an open channel for the entire length of Dry Gut rather than partially in a closed culvert	Negligible (permanent)	Water flow observations; design to control erosion and deposition; monitor erosion and deposition	**Negligible** (permanent)

Dry Gut	Minor adverse	No interruption of flow to lower Dry Gut	Negligible (permanent)	Water flow monitoring; monitor erosion and deposition	**Negligible** (permanent)

5.9. Waste Management

2007 Reference design

The fact that the concrete culverts and attenuation dam are no longer required means that a significant quantity of solid waste, such as cement bags, waste concrete, scrap rebar, etc. will no longer need to be disposed. The demolition of the temporary attenuation dam wall would have produced an excessive amount of construction rubble, which would have required additional haulage to a suitable spoiling area.

2013 Open Channel Proposal

One of the most beneficial outcomes of the open channel excavation is that it will provide suitable rock for the Dry Gut fill, which would otherwise have to be found elsewhere. If it is assumed that the cliffs and outcrops are all a potential source of suitable material, and assuming that these habitats all seem to house a number of endemic, rare species, it stands to reason that most, if not all, alternative potential sources of fill would have similar sensitivity to disturbance. Added to that, the cliffs and rocky outcrop areas tend to be more visible from vantage points across the island and therefore most quarrying activities will have a visual impact on either residential areas or scenic walks. A further consideration is that any other source of rockfill will have to be accessed, meaning that a new haul road would have to be created – which in itself would have a potential impact on land take, invertebrates, lichens, flora, and aesthetics (dust, noise and visual). Thus in the greater scheme of things, it is likely that no other sources of suitable rockfill can be found which would not have equal if not a greater impact on the environment than the one proposed in Dry Gut.

However, not all the material emanating from the open channel cut will be suitable for use in the bulk fill and this will have to spoiled in one of the two existing spoil areas: upstream of the Dry Gut fill, or in a valley to the east of the runway (known as Middle Fill). As these spoil areas already exist the incremental impact will be low.

The consequences of the proposed new design thus have a net **beneficial** effect with regards to waste disposal.

Table 5.10: Waste management: comparison of 2007 reference design and proposed 2013 open channel design and summary of effects

Location	**Residual effect from 2007 reference design**	**Potential changes with 2013 Proposal**	**2013 effects without mitigation**	**Additional mitigation required**	**Residual effect from 2013 reference design**
Bencoolen and Dry Gut	Not assessed	-Provision of suitable material for the Dry Gut fill as a result of open channel	Moderate beneficial (permanent)	Provision of spoiling areas- (valley to the east of Prosperous Bay	Moderate beneficial (permanent)

		excavation; -some material excavated from the open channel cut may have to be spoiled; -reduction in concrete waste and empty cement bags (contractor to export off island); -reduction in building rubble that would have been produced with demolition of temporary dam wall.		Plain (known as Middle Fill) and upstream from Dry Gut fill) -	

6. CONCLUSIONS

A summary of the impacts described above is provided in the table below. The table also shows the direction of change in residual impact rating: reduced impact (positive), same impact (neutral) or a worse impact (negative).

Table 6.1: Description of change between the 2007 reference design and the proposed open channel

Topic	**Description of change between the reference design and the residual impacts of the proposed 2013 design for Dry Gut open channel**	**Positive, negative or neutral change**
Land use	Increase in landtake on southern face of Dry Gut; decrease in footprint upstream from Dry Gut Fill • 2007 ES significance: **Not assessed** • Revised significance: **Minor adverse** (permanent)	Negative
Noise and vibration	Displacement of noise and vibration impacts due to blasting (from attenuation dam site to southern face of Dry Gut) • 2007 ES significance: **Minor adverse** (construction only) • Revised significance: **Minor adverse** (construction only)	Neutral
Air quality and dust	Increase in dust emissions due to quarrying activities on southern face of Dry Gut	Neutral

	• 2007 ES significance: **Very significant to major adverse** (construction only) • Revised significance: **Very significant to major adverse** (construction only); **minor adverse** (permanent)	
Carbon emissions	No cement, rebar, water or crushed stone required to fabricate concrete culverts and therefore reduction in carbon emissions associated with their production, shipping and trucking to site. • 2007 ES significance: **Minor adverse** (construction only) • Revised significance: **Minor adverse** (construction only)	Neutral
Terrestrial ecology and nature conservation	Temporary attenuation dam site overlapped with a proposed national protected area; new site does not overlap with any areas of ecological constraints as shown in Figure 9.1 of 2007 ES. • 2007 ES significance: **Minor adverse** (temporary) • Revised significance: **None** Wirebird territories were affected by the temporary attenuation dam option but will not be affected by the open channel proposal • 2007 ES significance: **Moderate adverse** (permanent) • Revised significance: **None** Possible impact on Madeiran storm petrels if breeding in lower Bencoolen area • 2007 ES significance: **Not assessed** • Revised significance: **Unknown** Lichens: none identified in Aptroot, 2007 (2007 ES) in either area, but significant spp. found by Pryce (Appendix B) on southern slope of Dry Gut • 2007 ES significance: **Not assessed** • Revised significance: **Minor adverse** (temporary) Rare and endangered plants: none identified at either site • 2007 ES significance: **Not assessed** • Revised significance: **Negligible** Rare and endangered invertebrates: no study sites at either location in 2007 ES. • 2007 ES significance: **Not assessed** • Revised significance: **Minor to moderate adverse** (permanent) depending on final channel design	Ecological constraints: Positive Wirebirds: Positive Madeiran storm petrels: Unknown Lichens: Negative Plants: Neutral Invertebrates: Negative
Landscape and visual amenity	Works on the southern slope of Dry Gut will not appear in views from residential areas; visual impact reduced by removing dam wall • 2007 ES significance: Bencoolen: **Minor adverse** (permanent); Dry Gut**: Major adverse** (temporary) • Revised significance: Bencoolen: **Moderate adverse** (permanent); Dry Gut: **Minor adverse** (permanent)	Bencoolen: Negative Dry Gut: Positive
Geology and hydrogeology	The route chosen for the open channel has avoided the zone of infiltration above the ecologically important cliffs and caves of lower Bencoolen	Negative

	• 2007 ES significance: **Not assessed** • Revised significance: **Minor adverse** (permanent)	
Surface water	The temporary attenuation dam would have caused a reduction in flows downstream in Dry Gut, both immediately below the dam and beyond the culvert outfall, which would have adversely affected aquatic species in the stream channel. The new open drain will create a new rocky bed habitat and flows downstream of the fill will be maintained. • 2007 ES significance: **Minor adverse** (temporary) • Revised significance: **Negligible**	Positive
Waste management	Open channel excavation provides a source of suitable rock for the Dry Gut bulk fill close to the works area and largely within the current ADAB. • 2007 ES significance: **Not assessed** • Revised significance: **Moderate beneficial** (permanent)	Positive

The study concludes that the main impacts of the open channel proposal will be on invertebrates and lichens – rated by the entomologist as **minor to moderate adverse** before mitigation is applied, but careful re-routing of the channel has ensured that the most sensitive areas will be avoided thus minimising the impact on the ecology to **minor adverse**. The open channel site will provide an opportunity for scientific research into the re-establishment of lichens and invertebrates, recreate an open watercourse and will greatly reduce the waste and carbon footprint of the airport site compared to the reference design.

The major benefit of this proposal is that it will provide most of the rock short fall for the Dry Gut fill from an area largely within the ADAB and certainly within the area of disturbance, without having to develop quarries elsewhere on the island.

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APPENDIX A

SCREENING OPINION LETTER FROM THE PLANNING DIVISION

Government of St. Helena
THE SECRETARIART
Planning Division
Planning Officer: Alfred Isaac

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Applicant Miss Janet Lawrence
Airport Project Director

Address Access Office
Post Office Building
Main Street
Jamestown

Date 5th April 2013

Dear Madam,

Application details/reference
Land Planning and Development Control Ordinance, 2008, s.32. Request for EIA Screening Opinion

Thank you for your request for an Environmental Impact Assessment (EIA) Screening Opinion dated 25th March 2013, received 25th March 2013, with regard to the proposed development at Dry Gut.

This Opinion has been prepared following the requirements of s.32 of the Land Planning and Development Control Ordinance, 2008 with regard to Screening. It has also referred to the guidance included within *A Procedural Manual for EIA on St Helena.*

Screening Opinion

Having considered the information provided by the Applicant, an EIA Screening has been undertaken. This has determined that there may be environmental impacts associated with the proposed development in regard to biodiversity, namely invertebrates. However the presence of any invertebrates in this particular area is unknown. In order to determine possible environmental impacts, a baseline survey would need to be undertaken by the applicant, to determine whether the development would have significant impact in this area. If any impacts are determined, appropriate mitigation measures should be proposed.

It is recognized that a substantial environmental impact assessment was done prior to the application for planning permission for the airport project works, approved in 2008. Where it is evident that issues have already been adequately covered this should be noted with relevant references.

Yours sincerely,

Isaac

Alfred V Isaac
Planning Officer

APPENDIX B

DRY GUT (SOUTHERN RIDGE) INVERTEBRATE SURVEY BY DAVID PRYCE

David Pryce Invertebrate Surveys

Dry Gut (southern ridge) Invertebrate Survey

Commissioned by Basil Read, St. Helena Airport Project

David Pryce
May 2013

APPENDIX C

SITE PLAN