CITY OF CAPE TOWN BULK WATER INFRASTRUCTURE PLANNING STUDY: FRESHWATER ECOSYSTEMS ENVIRONMENTAL IMPACT ASSESSMENT REPORT

April 2008

DRAFT REPORT

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1 INTRODUCTION

1.1Background

A joint venture of Orrie Welby-Solomon cc & Associates/BKS (Pty) Ltd (OWS / BKS JV) were appointed by the Bulk Water Department of the City of Cape Town to determine the most appropriate location for a water treatment plant (WTP), reservoirs and associated infrastructure and pipelines, for the transport, storage and treatment of water from the new Berg River Dam for supply to Cape Town. A feasibility study, which identified a number of suitable alternatives, commenced in 2004. Chand Environmental were subsequently requested to manage an environmental impact assessment (EIA) process that would assess the environmental impacts associated with the identified alternatives, and produce an environmental impact assessment report (EIR). The Freshwater Consulting Group was commissioned in February 2006 to undertake an assessment of the alternatives with specific regard to the freshwater ecosystems that would be impacted by them. The following report is a standalone document, incorporating some of the information presented in the scoping report during the feasibility phase (Snaddon & Ewart-Smith, 2005).

Three potential location options for the WTP and its associated infrastructure (roads and pipelines) (Options A, B and G) have been proposed in the Muldersvlei area. Three alternative bulk water pipeline alignments have been proposed – a "high route" and a "low route", with some additional alternative routings along the way, and a "preferred route", which is a combination of various sections of the high and low routes. The main sections of pipe are as follows:

- Dasbos pump station to Dasbos tunnel outlet: total pipeline approximately 2km
- Dasbos to Klapmuts: total pipeline length of approximately 26km
- Muldersvlei to Spes Bona: total pipeline length of approximately 12km

The specific aims of the EIA were to:

- Identify the impacts associated with each of the proposed pipeline routes and locations for the water treatment plants. Impacts associated with both the construction and operational phases of the bulkwater pipeline project were identified, with reference to those identified during the Scoping Phase.
- Recommend mitigation measures for the minimisation of negative impacts and the maximisation of the positive impacts of the proposed bulkwater project.
- Provide a comprehensive assessment of the significance of the impacts associated with the proposed bulkwater project. The criteria that were used for this comparative assessment were drawn from the EIA Regulations, published by the Department of Environmental Affairs and Tourism (April 1998) in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989). The impacts associated with all pipeline and treatment plant alternatives were assessed, in addition to those associated with the "no development" option, which comprises the status quo.

1.2Limitations

There was limited scope for primary data collection – the biota and water quality were not sampled at the sites visited. Thus, identification of rare or endangered plant and animal species was not

included in the scope of the study. Where possible, other reports on the affected ecosystems were consulted for such data.

Design details for the pipeline and water treatment plant were not provided, as it is understood that these will be finalised at a later stage of the project. This means that the impacts described in the report are generic to construction projects of this nature and extent.

1.3Overview of proposed project

The proposed bulk water pipeline would connect with the existing DWAF RSE tunnel system, at the Dasbos outlet, situated in the upper Berg River catchment. The pipeline would begin at the Dasbos pump station located just downstream of the Berg River Dam (currently under construction), and would run parallel to the DWAF pipeline, to the Dasbos tunnel outlet (see Appendix 1 for map of this section of pipeline). From here, the pipeline would be routed in a north-westerly direction past Klapmuts, crossing the N1 close to the R101, and then entering the Mosselbank River catchment where it would discharge water into the future Spes Bona Reservoir north of Durbanville. Along this route, the pipeline has a few alternative alignments, all of which will impact on several small streams that enter either the Berg or the Mosselbank rivers, in addition to crossing both the Dwars River (a major tributary of the Berg) and the Mosselbank itself. A number of relatively small natural and artificial (associated with farm dams) wetland patches are also situated along the pipeline routes.

All of the proposed alternatives for the location of the water treatment plant are situated in the Muldersvlei area. Three alternative sites for the WTP and reservoir have been proposed, all of which are located on private farms. WTPA and WTPB are located north of the N2 and WTPG is located to the south of the N2, near Klapmuts.

1.4General description of freshwater ecosystems within the study area

The Berg River has its source in the Drakenstein and Franschhoek Mountains south of Franschhoek, and the river discharges into the Atlantic Ocean near Velddrif, some 285 km away. The river reaches within the study area are typical of the foothill, cobble-bed geomorphological subregion. Major tributaries that enter the river within the study area are the Franschhoek, Wemmershoek and the Dwars rivers. There is also a fairly high density of smaller drainage lines entering the river in this part of the catchment, which is underlain by weathered and fractured rocks, mostly of the Malmesbury and Table Mountain Group. In past work, these foothill reaches of the Berg River have been accorded a “moderately modified” ecological status – i.e. where a loss and change of natural habitat and biota has occurred, but basic ecosystem functioning appears to be predominantly unchanged. These reaches have also been assessed as being of “very high” ecological importance.

The Dwars River is an important perennial tributary of the Berg, flowing through heavily cultivated fruit-growing areas and the town of Pniel. This river is a foothill, cobble-bed system typical of the Fynbos Biome – instream habitat is typically riffle-run sequences with some pools and marginal vegetation. Water quality on the Dwars River is impacted by runoff from Pniel, farming activities (e.g. severe impacts at times as a result of runoff from Boschendal piggery) and limited industrial

activity in the area. During high flows, the Dwars River has high levels of phosphorus and total suspended solids, due to surface runoff from agricultural areas (e.g. Day, 2004).

The Mosselbank River rises in the low hills of Kraaifontein, near the Tygerberg Zoo, and flows in a westerly direction, passing first through an agricultural area, with occasional informal settlements, and then into farmland (Day *et al*., 1999). Downstream of the Kraaifontein / Durbanville area, the Mosselbank River is joined by a number of tributaries, the largest of which is the Klapmuts River. The Maasdrift Canal - a canalised tributary of the Mosselbank River that flows through the urban area of Kraaifontein, where it receives treated effluent from the Kraaifontein sewage works - joins the Mosselbank River near Lichtenburg. Downstream of its confluence with the Klapmuts River, the Mosselbank River meanders westwards towards the small farming settlement of Philadelphia, where it enters the Diep River. The Diep River flows into Rietvlei near Milnerton - Rietvlei was declared a Protected Natural Environment in 1989, and is of particular ecological importance in terms of its birdlife. The upper reaches of the Mosselbank have been classified as a "wetland transitional" river (Day *et al*., 1999), and in past reports, these reaches have marginally been accorded a "moderately modified" ecological status. The fact that the Mosselbank River has retained its seasonal flow regime, is still associated with extensive riparian wetlands in many places along its length and, most significantly, is a tributary of the Diep River, which feeds Rietvlei, has resulted in the river being accorded a "very high" ecological importance (Day *et al*. 1999).

1.5Conservation importance of affected freshwater ecosystems

The following sections provide assessments of the conservation importance of the freshwater ecosystems that will be impacted by the construction and operation of the bulk water pipeline. These assessments were reported in the Freshwater Scoping Report (Snaddon & Ewart-Smith, 2005), which provides detail on the methods used to assess the systems, and are also provided in Appendix 1. Briefly, the conservation importance of the rivers and streams is based on assessments of the ecological importance and sensitivity of the systems, and the habitat integrity of the riparian and instream characteristics. For wetlands, conservation importance was determined based on the quality of wetland habitat, and the size and type of wetland.

1.5.1Dasbos pump station – Dasbos outlet (Layout Plan 4)

The first 2 km of the bulk water pipeline are proposed to start at the Dasbos pump station sited below the Berg River Dam, and then to join up with the Dasbos-Muldersvlei section of pipeline just below the Dasbos outlet. A pipeline is currently being built more-or-less along this same route, in order to connect the Berg River Dam with the existing Riviersonderend-Berg-Eerste River Water Scheme. The pump station and first few hundred metres of the bulk water pipeline are located within the Berg River floodplain, and would impact on a floodplain wetland (which is also fed by a smaller stream coming down the slopes of the mountain) that was considered to be of **moderate** conservation importance. This is due to the importance of this wetland in providing good quality (currently) wetland habitat, and also in its role as an ecological corridor associated with the Berg River. The Berg River has and will be heavily impacted by the construction of the dam, and thus maintaining the ecological integrity of the riverine corridor is of critical importance.

Further along the route of the pipeline is a braided drainage area that lies within the Waterval River sub-catchment (itself part of the Berg River catchment). These streams were assessed to be of high ecological importance and sensitivity. The streams are considered to be "…unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species). These rivers

(in terms of biota and habitat) may be sensitive to channel / bed modifications but in some cases, may have a substantial capacity for use." (see Scoping Report for definition of high ecological importance and sensitivity). Both the instream and riparian habitat integrity were assessed as being "moderately modified" (i.e. "a loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged"). These braided channels have been modified primarily as a result of alien tree encroachment. However, these trees are currently being removed, and recovery appears to occur fairly rapidly on these slopes (as can be seen nearby below the Dasbos outlet). Overall, this braided river was assessed to be of **high** conservation importance.

The pipeline also traverses a wetland that is located at the bottom of the steep slope below the outlet – this area used to be covered with pine trees which have now been removed. This wetland was assessed as being of **moderate to high** conservation importance, due to the fact that this is a fairly large seep area supporting diverse wetland vegetation components, although many of these components are characteristic of pioneer-state vegetation. This wetland probably forms as a result of the flattening out of the slope, and the resultant retention of water that seeps out of the mountain at this point.

1.5.2 "Low route" pipeline (& alternatives) – Dasbos-Klapmuts section (Layout Plan 3 and 4)

The Dasbos - Klapmuts section of the "low route" pipeline crosses the Waterval and Dwars rivers, which were both assessed to be of high ecological importance and sensitivity. The instream habitat integrity of the sites assessed on these two rivers was categorised as "moderately modified", largely due to the presence of road crossings. The riparian habitat integrity was assessed as "largely modified" in both cases, largely due to encroachment by alien plant species and removal of indigenous vegetation. These rivers are considered both to be of high conservation importance, and thus the implementation of mitigation measures recommended for reducing the short-term impacts on these rivers, and avoiding any long-term impacts is of critical importance. In addition, measures could be implemented to improve the state of the riparian habitat, such as removal of alien trees.

Further, the low route crosses the "Bellingham Stream", the Graham Beck Stream, Stream a, and Stream d, all of which were assessed as having **moderate** ecological importance and sensitivity – i.e. "…considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These sites are all situated in the Berg River catchment. Most of these sites were assessed as having "largely to extensively modified" instream and riparian habitat, with the exception of the Graham Beck Stream on the Graham Beck wine farm, where the instream habitat integrity was considered to be only moderately modified – this stream has some good quality riffle and run habitat, typical of a stream in this area, especially in comparison with the other streams in this area that have been reduced to muddy trickles. Considerable modification of the beds and banks of these streams has occurred over the many years of agricultural activities in this area, however, these streams still provide important links between the mountain slopes and the Berg River itself, and so are of **moderate** conservation importance.

The remaining riverine sites impacted by the low route (streams c, e and h) were assessed as having low / marginal ecological importance and sensitivity – i.e. "…not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to channel / bed modifications and usually have a substantial capacity for use". All of these sites are located on

small streams that enter the Berg River along its left bank, and all have been heavily impacted by agricultural activities on the slopes of the mountains. These streams have been altered to become soft-bottomed (sand and mud) systems as a result of erosion and sedimentation, and they no longer provide the type or quality of habitat typical of the foothill, cobble-bed streams in this area. This assessment is reflected in the categorization of the instream habitat integrity of these sites as "largely modified". In addition, the riparian habitat was assessed as "largely to extensively modified". These streams are considered to be of **low** conservation importance.

The low route would cross three wetlands – one of these (low route 10) was assessed as having a **moderate** conservation importance. Although small and artificial (associated with a farm dam), the quality of the wetland vegetation here is such that it provides relatively good quality wetland habitat. The remaining two patches of wetland encountered along this route were assessed to be of **low** conservation importance, as both patches were of limited size and so limited value as habitat.

The various alternative routings on the low route do not cross any additional freshwater ecosystems.

1.5.3 "High route" pipeline (& alternatives) - Dasbos-Klapmuts section (Layout Plan 3 and 4)

The high route also crosses both the Waterval and Dwars rivers, assessed to be of **high** conservation importance. In addition, this route crosses Stream d, "Bellingham Stream", Stream a, Stream b, and the Graham Beck Stream which were assessed to be of **moderate** importance. Once again, with the exception of the Graham Beck Stream, these sites were assessed as having "largely to extensively modified" instream and riparian habitat, but are important systems in terms of providing ecological corridors through agricultural land (see Section 1.5.2 above).

The remaining streams were all of **low** conservation importance. In addition, all of the wetland patches impacted by this route were considered to be of **low** conservation importance.

The alternative routings for the high route on this section of pipeline cross the same streams as the high route, and one additional sedge wetland on the Graham Beck farm (see High route alternative 30 in Appendix 1), considered to be of **moderate** conservation importance.

1.5.4Preferred pipeline route – Dasbos–Klapmuts section (Layout Plan 3 and 4)

The preferred route mostly follows the low route, taking a few of the alternative routings, particularly one section of pipeline that will follow the alternative routing to the south of, instead of the north of the R45. The preferred route avoid one significant wetland, of **moderate** conservation importance, that would be impacted the low route (impact area F10, or low route 10), and does not impact on any additional ecosystems.

1.5.5"Low route" pipeline (& alternatives) - Spes Bona-Muldersvlei section (Layout Plan 1)

The low route would cross both the Mosselbank and its major tributary, described above (Section 1.4), and would also impact on four wetlands. The Mosselbank River was assessed as being of **moderate to high** conservation importance, due to its importance as a tributary of the Diep River, and an important riverine corridor in the area. Its tributary was assessed as being of **moderate**

importance – this river is also an important corridor, but has been considerably modified (especially in terms of water quality) as a result of intensive agricultural activities in the area. All of the wetlands impacted by this pipeline route were considered to be of **low** conservation importance, due to their limited size. It should be noted, however, that although these systems do not offer high quality wetland habitat, their collective presence as patches of habitat in agricultural area does increase their ecological importance.

1.5.6 "High route" pipeline (& alternatives) - Spes Bona-Muldersvlei section (Layout Plan 1)

The high route (and its alternatives) also crosses the Mosselbank River, of **moderate to high** importance as described above, and a small tributary of the Mosselbank to the west of the R302 (of **low** conservation importance due to impacts of farming), and also impacts on two wetland patches which were assessed as being of **low** conservation importance.

1.5.7Preferred route - Spes Bona-Muldersvlei section (Layout Plan 1)

The preferred route for this section of the bulk water pipeline follows the high route, and thus avoids the wetlands that would be impacted by the low route. This preferred route would, however, still cross over the Mosselbank River at one point, and, while it would impact on the small tributary of the Mosselbank to the west of the R302 (**low** conservation importance), it avoids the major tributary higher up the catchment (**moderate** importance).

1.5.8WTP A and infrastructure (Map 1)

WTP A is located on farmland, north of the N1. The location of the WTP and the reservoir would impact on a small earth farm dam, which has some wetland habitat around its perimeter. However, this is artificial habitat, and, due also to its small size, is considered to be of **low** conservation importance.

The pipelines that would be necessary to link up with the proposed bulk water pipeline and with the existing Wemmershoek pipeline, would impact on a number of wetlands (of **moderate** and **low** conservation importance), and on a small stream in the Mosselbank catchment, of **moderate** conservation importance.

The access road makes use of an existing road and so would not impact on any freshwater ecosystems.

1.5.9WTP B and infrastructure (Map 2)

The site proposed for the location of WTP B and its reservoir would not impact on any freshwater ecosystems. The pipelines would impact on wetlands that are all of **moderate** conservation importance, and the same stream as that described for WTP A above, of **moderate** conservation importance.

The access roads would not impact on any additional freshwater ecosystems.

1.5.10WTP G and infrastructure (Map 3)

The site proposed for the location of WTP G and its reservoir would not impact on any freshwater ecosystems. The pipelines would impact on fewer wetlands than both WTP A and B, but all of these are of **moderate** conservation importance. This option would also impact on the stream of **moderate** conservation importance, described above.

The new paved road required for this option would not impact on any additional freshwater ecosystems.

Map 1 WTP A and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.

Map 2 WTP G and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.

Map 3 WTP G and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.

2 ASSESSMENT AND MITIGATION OF IMPACTS

2.1Protocol for the assessment of impacts

The evaluation of impacts was undertaken as stipulated in the EIA Regulations published by the Department of Environmental Affairs and Tourism (April 1998), in terms of the Environmental Conservation Act No. 73 of 1989, making use of the definitions and criteria detailed below.

Nature of the impact: Description of the **type of effect** the activity would have on the affected environment.

Extent: Reflects the importance of the environment on a **local** (site area), surrounds (site area and its surroundings), **regional** (Western Cape) or a **national** scale: impacts on threatened wetlands or seeps, or those that provide ecosystem functions on a regional or national scale are considered to constitute a regional or national scale impact.

Duration:

- **Short term** (0-5 years);
- **Medium term** (6-15 years);
- **Long term** (16-30 years);
- **Permanent** (mitigation, either human or natural, will not occur in such a way or in such a time span that the impact can be considered transient).

Intensity:

- **Low** (affects the environment such that natural functions or processes are not affected – or not degraded significantly more than their present state);
- **Medium** (affected environment is altered but natural functions or processes continue, albeit in a modified/ increasingly modified way);

- **High** (natural functions or processes are altered to the extent that they will temporarily or permanently cease).

Probability of occurrence:

- **Improbable** (low likelihood of the impact occurring);
- **Probable** (distinct possibility of the impact occurring);
- **Highly probable** (the impact will most likely occur).
- **Definite** (impact will occur regardless of any prevention measures)

Status of the impact:

- **Negative**
- **Positive**
- **Neutral**

Accumulative impact: Consideration must be given to the extent of any accumulative impact that may occur due to the proposed development. Such impacts must be evaluated with an assessment of similar developments already in the environment. Such impacts will be either **positive** or **negative**, and will be graded as being of **negligible**, **low**, **medium** or **high** impact.

Degree of confidence in predictions: It is necessary to state the degree of confidence (**low**, **medium** or **high**) in the predictions based on the available information and level of knowledge and expertise.

Significance of impact:

- **No significance:** the impacts do not influence the environment in any way.
- **Low significance:** the impacts will have a minor influence on the environment. These impacts require some attention to modification of the project design where possible, or alternative mitigation.
- **Moderate significance:** the impacts will have a moderate influence on the environment. The impact can be ameliorated by a modification in the project design or implementation of effective mitigation measures.
- **High significance:** the impacts will have a major influence on the environment.
- **No Development:** the impacts will have the "no-go" implication on the development or portions of the development regardless of any mitigation measures that could be implemented. This level of significance must be well motivated.

2.2Legislation and guidelines for the conservation and management of rivers and wetlands

The following sections briefly summarise those sections of the South African legislation that pertain to the conservation and management of rivers and wetlands:

a) NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO 107, 1998)

The National Environmental Management Act of 1998 (NEMA), outlines measures that…."prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Of particular relevance to this assessment is Chapter 1(4r), which states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

b) RAMSAR CONVENTION OF 1995

Signatories of the convention (which include South Africa) are obliged to promote the conservation of wetlands, whether they are listed or not.

c) CONSERVATION OF AGRICULTURAL RESOURCES ACT (Act 43 of 1983)

Key aspects include legislation that allows for:

Section 6: Prescription of control measures relating to the utilisation and protection of vleis, marshes, water sponges and water courses. These measures are described in regulations promulgated in terms of the Act, as follows:

Regulation 7(1): Subject to the Water Act of 1956 (since amended to the Water Act 36 of 1998), no land user shall utilise the vegetation of a vlei, marsh or water sponge or within the flood area of a water course or within 10 m horizontally outside such flood area in a manner that causes or may cause the deterioration or damage to the natural agricultural resources.

Regulation 7(3) and (4): Unless written permission is obtained, no land user may drain or cultivate any vlei, marsh or water sponge or cultivate any land within the flood area or 10 m outside this area (unless already under cultivation).

d) NATIONAL WATER ACT

The Water Act recognises the importance of water resources and the need to protect them, and lists the protection of water resources and the associated aquatic and semi-aquatic biological diversity as part of its purpose. The Water Act lists both consumptive and non-consumptive (i.e. activities that may impact on the condition and functionality of water resources) water uses. Examples of non-consumptive uses relevant to the bulkwater pipeline project, and that require authorisation, are:

- Impeding and diverting the flow of water in a watercourse;
- Discharging waste or water containing waste into a water resource or in a manner that may detrimentally impact on the water resource, and
- Altering the beds, banks, course or characteristics of a water resource.

e) NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT

The purpose of the Biodiversity Act is to:

- provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998;
- the protection of species and ecosystems that warrant national protection;
- the sustainable use of indigenous biological resources;
- the fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources, and

- the establishment and functions of a South African National Biodiversity Institute.

The Biodiversity Act deals with the protection of threatened and endangered ecosystems and species, and places limitations on activities that may impact on ecosystems, communities and species. The Act also describes which activities require permits and the process in obtaining these authorisations.

f) CAPE NATURE CONSERVATION ORDINANCE (Ordinance 19 of 1974; amended in 2000)

This ordinance provides measures to protect the natural flora and fauna, as well as listing nature reserves in the Western Cape that are managed by the Western Cape Nature Conservation Board (WCNCB). This ordinance, with the Western Cape Nature Conservation Board Act of 1998 was amended in 2000 to become the Nature Conservation Laws Amendment Act. Lists of endangered flora and fauna can be found in this act.

2.3Potential impacts

The impacts associated with the construction and operation of the bulk water pipeline, the water treatment plant and reservoir, and all associated infrastructure, have been grouped into four main impacts for assessment. These are:

Loss of wetland habitat. As pointed out in the Scoping Report, the proposed pipeline routes will cross over several wetlands. The construction of the pipeline will thus have a significant impact on these ecosystems, which will be dug up, and vegetation removed, in order to lay the pipe underground. A major concern is the increased likelihood of erosion within the wetland, which can lead to creeping erosion moving up and down the system. Should it be a requirement that the pipeline route be kept clear of vegetation for maintenance purposes, this loss of wetland habitat would be permanent. The construction process is also likely to lead to pollution of marshy areas, due to the mobilisation and deposition of sediment, leakage of oil and fuels from machinery, and dumping of building material and rubble into the wetlands. The operation phase of the pipeline is unlikely to lead to any direct deterioration in water quality, except for the accumulative downstream impacts associated with the loss of wetland habitat.

Loss of connectivity within impacted wetlands. The laying of the pipeline across a wetland can lead to a loss of connectivity between the upstream and downstream sections. This is especially true of pipelines that lead to the draining of water down into the groundwater instead of allowing water to sit on the surface. Further, if the wetland vegetation is removed and does not recover, then a degraded swathe cutting through a wetland will also lead to a loss of connectivity within the wetland. This loss of connectivity will lead to a deterioration of both the upstream and downstream sections of wetland.

Loss of riverine habitat. The pipeline routes also cross a number of streams and rivers, and the preferred method, for financial reasons, is to lay the pipes under these systems, rather than cross over the stream or river. This constitutes a significant impact on these ecosystems for the same reasons outlined above for wetland habitat loss. This impact will be more severe where the presence of rock and bedrock requires the blasting of river beds and banks. This will reduce the likelihood of recovery. The bulldozing of the river banks and bed can lead to erosion, due to a shift in the shape of the system, and mobilisation of sediments.

Loss of connectivity within impacted rivers or streams. The laying of the pipes under the streams and rivers could lead to a loss of connectivity between the up- and downstream reaches of the system. The construction process can also lead to the obstruction of flow, and the build-up of sediments and nutrients that should rather be flushed through the system.

2.4Impact assessment tables

The following assessment tables describe the expected impacts on the freshwater ecosystems affected by the proposed pipeline routes, and the proposed locations for the water treatment site, reservoir and associated infrastructure (i.e. roads and pipelines). The tables include impacts associated with both the construction and operational phases of the bulkwater project. The tables refer to the recommended mitigation measures, and provide an assessment of the impacts with and without mitigation. The mitigation measures are discussed in Section 0.

2.4.1Pipeline routes

Dasbos pump station to Dasbos outlet

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity – the pipeline could effectively cut the wetlands off from subsurface seepage up the slopes (this is especially so for the Berg River floodplain wetland)	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Low	Medium
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Moderate
Level of significance after	Low negative	Low negative

mitigation		

Nature of impact	Loss of riverine habitat – one stream crossing (over more than one channel) would be required	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Medium-term	Medium
Intensity	Medium to high	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Medium
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

Dasbos outlet to Klapmuts

HIGH ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative to no significance

LOW ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**

Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short-term
Intensity	Low to medium	Low to medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

PREFERRED ROUTE

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**

Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short-term
Intensity	Low to medium	Low to medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

<u>Muldersvlei to Spes Bona</u>

HIGH ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

LOW ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat

STAGE	CONSTRUCTION PHASE	OPERATION PHASE
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional

Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

PREFERRED ROUTE

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium

Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

2.4.2WTP sites and infrastructure

Option A

Nature of impact	Loss of wetland habitat at the WTP site – this is a farm dam so is artificial wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short-term	Permanent
Intensity	Low	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	None	Low positive

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines to from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines to from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the pipelines connecting reservoir A with the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the pipelines connecting reservoir A with the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

Option B

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines from the Dasbos pipeline to WTP B and from reservoir B to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines to from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative

Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the pipelines connecting reservoir B with the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the pipelines connecting reservoir B with the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

Option G

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines from reservoir G to the Spes Bona pipeline, and reservoir G to Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low

Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines from reservoir G to the Spes Bona pipeline, and reservoir G to Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the laying of pipelines from reservoir G to the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the laying of pipelines from reservoir G to the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)

Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

2.5Mitigation measures

2.5.1Construction phase

It should be noted that site-specific impacts can only be identified once the specific engineering options have been provided and evaluated. In addition, most of the impacts associated with construction can be mitigated through use of strict guidelines relating to the design, pre-construction, construction and clean-up phases of the project, all of which would be outlined in a detailed environmental management plan (EMP) for the project and enforced by an on-site environmental control officer (ECO). The impacts and mitigation measures listed below apply to all areas where the pipeline impacts on an aquatic ecosystem, but would be particularly applicable to those river / stream sites that were assessed as having fairly good quality riparian and / or instream habitat (i.e. at worst, moderately modified), and those wetlands assessed as being of moderate conservation importance.

Table 1 Impacts and mitigation measures associated with the construction of the pipelines and WTP.

Impact	Mitigation
Loss of wetland and / or riverine habitat, through removal of indigenous riparian vegetation from rivers and wetlands	▪ Ideally, alignment of the pipeline should attempt to avoid wetlands and rivers - especially for sites listed to be of moderate to high conservation importance. ▪ The design of the pipe should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area), and sensitive ecosystems should be demarcated prior to any construction activities, so that these can be avoided. ▪ Where construction occurs: o Identification and removal of rare / endangered plant species where appropriate – a botanist should visit the site in late winter / spring to identify sites and plants. o Removal and bagging of plants useful for rehabilitation of banks ▪ Removal of alien species (e.g. acacias, kikuyu grass) can be considered as a positive impact of construction.

Impact	Mitigation
	▪ Removal of vegetation should be kept to a minimum, and cleared areas must be re-vegetated after clean-up. A detailed planting plan should be developed, in consultation with a landscaper and ecologist.
Loss or deterioration of wetland and riverine habitat through bulldozing and blasting of river banks / wetlands, leading to erosion	▪ Ideally, alignment of the pipeline should attempt to avoid wetlands and rivers - especially for sites listed as of moderate ecological or conservation importance. ▪ Construction should take place during the dry season, in order to minimise the impacts of bulldozing and blasting. ▪ Where river crossings are necessary, attempts should be made to make use of existing crossings (such as road bridges) ▪ Consideration should be given at the design phase to remedial shaping of banks to their near-natural slope, geomorphological and bed characteristics and re-vegetated after clean-up. ▪ Banks should be re-vegetated after clean-up.
Loss of connectivity and deterioration of habitat through disruption of flow regime leading to nutrient / sediment build-up and eutrophication	▪ Disruption of flow should be kept to a minimum, but where necessary, temporary diversion measures should allow flushing of the system to prevent build-up of material. For perennial rivers, construction should take place in late summer, so that winter rains will flush the system after construction. For seasonal rivers, construction should take place when the system is dry. ▪ Diversion techniques should take measures to limit erosion from temporary channels into streams or rivers. ▪ The final design of temporary diversion measures should be ratified by a freshwater ecologist. ▪ No obstructions to flow shall remain in the river or wetland after construction is completed.
Dumping of building material and rubble – resulting in potential contamination of river as a result of accidental runoff, or in infilling and general degradation and disturbance to wetlands and floodplains	▪ All building materials should be stored away (at least 50m) from aquatic ecosystems and the areas bunded appropriately such that there will be no runoff from these areas towards aquatic systems. All building materials should be removed after construction. ▪ If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural ecosystem. ▪ The pipeline contractor should work the pipeline in sections, backfilling as they go, which will reduce the width of disturbed area – i.e. it is not as necessary to spread the spoil wide, if it can spread along a greater length
Deterioration in wetland and riverine habitat through spillage of building materials and oil / fuel	▪ Washing of vehicles and machinery should take place well away (50m) from aquatic ecosystems. All machinery should be regularly checked for leaks. ▪ No runoff shall enter the wetlands, streams or rivers.

2.5.2Operational phase

The impacts associated with the operational phase of the project relate primarily to the long-term loss or deterioration of aquatic habitat, and the long-term or permanent loss of connectivity within the impacted ecosystems. This is applicable both to the WTP site and the pipeline, as, although the pipe will be buried, there will be some long-term disturbance within the approximately 27m-wide pipe servitude along the route. The significance of these impacts would be influenced by the nature and extent of the habitat destroyed or altered, and the success of restoration after construction. A detailed EMP should be developed which will deal with ongoing monitoring and maintenance of the pipeline route, to minimise the negative impacts of the operational phase.

Table 2 Impacts and mitigation measures associated with the operation of the pipelines and WTP.

Impact	Mitigation
Permanent loss of wetland and riverine habitat, and loss of connectivity within impacted ecosystems	▪ This should be minimised through sensitive alignment of the pipe and location of the WTP to reduce the impact on the aquatic environment. ▪ The pipes should not be laid in coarse gravel "sleeves", these act as subsurface drains, which would be a problem in a wetland area, and would also disrupt the connectivity within the rivers / streams. The pipe should rather be contained in a solid sleeve. ▪ The impacted footprint of the pipeline and WTP site should be kept to a minimum, e.g. reducing the depth to which the pipes are laid, where possible.
Loss of habitat through ongoing erosion	▪ The geomorphological characteristics of the impacted ecosystems must be re-instated after construction – this will reduce the likelihood of increased erosion or sedimentation. ▪ If it is necessary to stabilise the river bed or banks with gabions, these should be kept to a minimum, and should be done in an ecologically sensitive manner. For example, gabions could be topsoiled to allow for the establishment of vegetation, which would also serve the purpose of reducing erosion.
Deterioration in wetland and riverine habitat through loss of indigenous vegetation	▪ Vegetation within the pipeline servitude should be allowed to recover (in some cases, re-planted), within the constraints of ongoing maintenance of the pipeline. ▪ Ongoing monitoring of the pipeline and WTP site and associated infrastructure should be implemented (part of the ongoing EMP) in order to ensure that exotic plant species are not introduced or become established due to the disturbance. ▪
Loss of artificial habitat, such as farm dams	▪ Artificial habitat can be re-created fairly effectively elsewhere. Planting of wetland plants in this "new" wetland will improve the ecological value of the ecosystem.

3 CONCLUSIONS AND RECOMMENDATIONS

- A summary of the assessment of the main categories of impacts associated with the construction and operation of the bulk water pipeline and the WTP and associated roads and pipelines, is provided in Table 3.

- An overall assessment of the impacts is provided in Table 4.
- In terms of impacts on freshwater ecosystems, the preferred WTP option is WTPG and its associated pipelines / roads. This option would impact on fewer wetlands than the other two options. The favoured routing for the bulkwater pipeline is the “preferred route”, from the Dasbos Outlet to Klapmuts, and the “preferred route” from Muldersvlei to the proposed Spes Bona reservoir. The pipeline running from the Dasbos Pump Station to the Dasbos Outlet will have highly significant negative impacts associated with it, but there are no alternatives for this route.
- The impacts associated with construction can be mitigated to some extent. This is more true for the wetlands than for the rivers – it is expected that the rivers will take some time to recover from the impacts of construction, even with the implementation of mitigation measures.
- Detailed construction and operational environmental management plans (EMPs) must be developed prior to construction, as these EMPs will deal in greater detail with the impacts and how to mitigate against them.

Table 3 Summary of the assessment of impacts associated with the construction and operation of the bulk water pipeline, and the WTP site and infrastructure.

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
Construction Phase					
WTP and infrastructure options					
WTP A	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
WTP B	Loss of wetland habitat	Medium		Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
WTP G	Loss of wetland habitat	Medium		Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
Dasbos pump station to Dasbos outlet					
	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low	Negative	Low	Low negative
	Loss of riverine habitat	Medium to high	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Dasbos outlet to Klapmuts					
High route (& alternatives)	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Low route (and alternatives)	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
Preferred route	Loss of wetland habitat	Medium	Negative	Low to moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Muldersvlei to Spes Bona					
High route (& alternative)	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None
Low route (& alternatives)	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None
Preferred route	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None
Operational Phase					
WTP and infrastructure options					
WTP A	Loss of wetland habitat	Low	Negative	Low	Low positive
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
WTP B	Loss of wetland habitat	Low		Moderate	Low negative
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
WTP G	Loss of wetland habitat	Low		Low to moderate	Low negative
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
Dasbos pump station to Dasbos outlet					
	Loss of wetland habitat	Medium	Negative	Low to moderate	Low negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of wetland connectivity	Medium	Negative	Moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Moderate negative
	Loss of riverine connectivity	Medium	Negative	Moderate	Low negative
Dasbos outlet to Klapmuts					
High route - (& alternatives)	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low	Negative	Low to moderate	Low negative to none
Low route - (& alternatives)	Loss of wetland habitat	Low	Negative	Moderate	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low to moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Preferred route	Loss of wetland habitat	Low	Negative	Low to moderate	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low to moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Pipeline alternatives at Muldersvlei					
Eastern alignments	Loss of wetland habitat	Low	Negative	Low	None
Midway alignments	Loss of wetland habitat	Low	Negative	Low	None
Western alignments	Loss of riverine habitat	Medium to high	Negative	Moderate	Low negative
	Loss of riverine connectivity	Low	Negative	Low to moderate	Low negative
Muldersvlei to Spes Bona					
High route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative
	Loss of riverine connectivity	Low	Negative	Low	Low negative
Low route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of riverine connectivity	Low	Negative	Low	Low negative
Preferred route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative
	Loss of riverine connectivity	Low	Negative	Low	Low negative

Table 4 Overall ratings of the impacts without and with mitigation (0 = no impact; L = low; M = moderate; H = high; - = negative; + = positive).

PIPELINE

Dasbos pump station to Dasbos outlet	Dasbos outlet to Klapmuts			Muldersvlei to Spes Bona		
Preferred route (one alternative)	High route (+ alternatives)	Low route + alternatives	Preferred route	High route + alternatives	Low route + alternatives	Preferred route
CONSTRUCTION PHASE						
M-H⁻ M⁻	M-H⁻ M⁻	M-H⁻ M⁻	M-H⁻ M⁻	H⁻ M⁻	H⁻ M⁻	H⁻ L-M⁻
OPERATIONAL PHASE						
M-H⁻ M⁻	H⁻ L-M⁻	H⁻ L-M⁻	H⁻ L-M⁻	M-H⁻ L-M⁻	M-H⁻ L-M⁻	M-H⁻ L-M

TREATMENT PLANT AND INFRASTRUCTURE

WTP A + infrastructure					WTP B + infrastructure					WTP G + infrastructure				
WTPA	Dasbos to WTP A	Wemmers to Res A	Res A to Wemmers	Res A to Spes Bona	WTPB	Dasbos to WTP B	Wemmers to Res B	Res B to Wemmers	Res B to Spes Bona	WTP G	Dasbos to WTP G	Wemmers to Res G	Res G to Wemmers	Res G to Spes Bona
CONSTRUCTION PHASE														
L- 0	L-M⁻ L⁻	0 0	M-H⁻ L-M⁻	0 0	0 0	L-M⁻ L⁻	0 0	M⁻ L-M⁻	M-H⁻ L-M⁻	0 0	0 0	0 0	M- L⁻	M-H⁻ L-M⁻
OVERALL RATING: M⁻ L-M⁻					**M-H⁻ L-M⁻**					**M⁻ L⁻**				
OPERATIONAL PHASE														
L⁻	L⁻	0 0	M⁻ L⁻	0	0	L⁻-	0 0	L-M⁻ L⁻	M⁻	0 0	0	0 0	L-M⁻ L⁻	M⁻

L+	0			0	0	0			L-		0			L-
OVERALL RATING: L-			**0**		**L-**		**0**			**L-**		**0**		

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APPENDIX 1: Description of sites visited along the pipeline routes. Site numbers (1, 2 etc) are for our identification purposes and do not necessarily imply a sequence.

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
Dasbos pump station to Dasbos outlet								
DasPump-Das 44	Floodplain wetland close to Berg River, below Dam site	▪ Seep area essentially within the Berg River floodplain. Various wetland species are evident here. ▪ Small stream traverses the wetland, approximately through proposed pumping station location.	wetland seep and streams	Berg				MODERATE – plays an important role as part of Berg River floodplain, important as ecological corridor, in addition to providing relatively good wetland habitat.
DasPump-Das 45	Stream I, braided channels east of Dasbos outlet	▪ Braided cobble / bedrock / sand streams, with a wider (3-4m) main channel and narrower side channels. ▪ Water flowing in channels at the time of site visit appeared clear and clean, with some algae noted. ▪ Riparian vegetation has been fairly heavily infested by alien tree species, mainly by Port Jackson (*Acacia saligna*), black wattle and pines. ▪ Instream vegetation was in good condition, comprising *Isolepis* spp., sedges, restio's.	foothill cobble-bed stream	Berg	C	C	HIGH	
DasPump-Das 46	Wetland below Dasbos tunnel	▪ Wetland is formed where steep slope flattens out – water seeps out of the slope, and is retained here. ▪ This area was previously forested with pine trees, but is now recovering well. ▪ Fairly diverse vegetation characteristic	wetland seep					MODERATE / HIGH - Large seep area supporting diverse wetland vegetation

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		of the “pioneer” stage of recovery was noted, such as *Eriocephalus* sp.. Other typical wetland species were also recorded, including restios and sedges, grasses (e.g. *Pennisetum macrourum*) and ferns (*Pteridium* sp.), that would indicate that this is a seasonal wetland / marsh.						components; form an integral part of the habitat mosaic within the landscape and, because of these habitat characteristics, may support rare or threatened biota
Muldersvlei to Dasbos outlet								
Low route 2	Waterval River, below Dasbos Tunnel outlet	▪ Cobble / boulder bed stream. ▪ Stream substrate is covered with algae, which indicates high organic load, probably from agricultural activities in upper catchment. Abstraction of water for irrigation has also reduced the volume and frequency of flushing flows necessary to rid the stream of algae. ▪ Riparian vegetation has indigenous elements (such as olive trees, *Olea europea* subsp. *africana*, and the wild almond, *Brabejum stellatifolium*), but is infested with alien trees such as long-leaf wattle (*A. longifolia*), black wattle (*A. mearnsii*) and Port Jackson (*A. saligna)*, an*d* also kikuyu *grass (Pennisetum clandestinum*).	foothill cobble-bed stream	Berg	C	D	HIGH	
Low route 1	"Bellingham Stream", small stream on southern side of Klapmuts Road	▪ Riverine site, macro-channel of approx. 5m width, flow is largely runoff from surrounding cultivated fields (vineyards) and overflow / leaks from upstream dams. Substrate is sand. ▪ Water quality appears relatively poor, as a result of agricultural runoff - water is opaque.	foothill cobble-bed stream	Berg	D	E	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		▪ Banks are infilled and steep. ▪ Riparian vegetation (closed canopy over stream) is almost entirely alien – willows, herbaceous shrubs, acacias (some of which have been chopped down). Vineyards encroach to within approx. 30m of the stream banks. Indigenous lilies (*Zantedischia aethiopica*) were present.						
Low route 31	Graham Beck Stream, Graham Beck wine farm	▪ This is a shaded cobble-bed, riffle / run stream, flowing through a 2m-wide channel (width decreases downstream, probably due to encroachment of farm buildings, roads and vineyards) and steep banks, which is reduced to a trickle in the dry months. Mud, probably sedimentation from bank disturbance, has settled on the stream bed in places – sedimentation increases with distance downstream. Little or no abstraction of water was noted until below this site, where abstraction leads to a proliferation of algae in the river. ▪ Water quality is probably relatively unmodified, with no algae recorded at the time of the site visit. ▪ The riparian forest is dominated by pines, oaks, black wattles and indigenous olives (alien invasion increases with distance downstream). A prolific understorey of herbaceous plants (mostly weeds, but also ferns near the river) is also evident.	foothill cobble-bed stream	Berg	C	D	MODERATE	
Low route 3	Stream a, flowing through L'Ormarins farm, southern side of Klapmuts	▪ Cobble bed stream. ▪ Banks have been modified through infilling, and are steep. ▪ Alien riparian vegetation includes oaks, eucalypts. Indigenous sedges were recorded within the stream and long its banks. ▪ Water quality appears to be poor,	foothill cobble-bed stream	Berg	D	D	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	Road	such as indicated by presence of algae – probably as a result of agricultural runoff entering stream.						
Low route 6	Dwars River, southern side of Klapmuts Road	▪ Cobble / boulder bed river, typical of foothill reaches. Channel is approx. 30 – 40m wide. ▪ Water quality appears poor – water is opaque indicating sediment transport. Runoff from the town of Pniël as well as from adjacent wine farms, is known to pollute the waters of the Dwars. ▪ Some indigenous riparian tree species (such as the willow *Salix capensis*), but many acacias and poplars have invaded the riparian belt.	foothill cobble-bed stream	Berg	C	D	HIGH	
Low route 7	Stream c, southern side of Klapmuts Road	▪ Small trickle over muddy substrate. ▪ Water quality appears relatively good – water is quite clear. ▪ Some arum lilies, wild almond, and *Rhus* spp. noted, but also aliens such as Sesbania sp., acacias and Spanish reed (*Arundo donax*).	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
Low route 8	Stream d, southern side of Klapmuts Road	▪ Channel of approx. 15m width, with deeply incised, steep banks. Mostly run on mud, but with some riffle over cobble. ▪ Water quality is very poor. ▪ Some indigenous elements present in riparian vegetation (a few large olive trees), but mostly aliens such as poplars, oaks. Vineyards encroach to within less than 20m of the stream.	foothill cobble-bed stream	Berg	D	D	MODERATE	
Low route 9	Stream e, on northern side of Klapmuts Road	▪ Very small (less than 3m wide) muddy-bottomed stream, largely dry due to abstraction of water by farmers. ▪ Some good quality, indigenous	foothill cobble-bed stream	Berg	D	D	LOW / MARGINAL	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		vegetation on stream banks (*Rhus* spp., *Olea europea*, *Eriocephalus* sp., *Persecaria* sp.), and a few alien acacias.						
Low route 10	Wetland on northern side of Klapmuts Road	▪ Patch of wetland with a muddy-bottomed stream flowing through it – this patch is located at the upstream end of a farm dam which creates this wetland habitat. A second stream is located to the west of the wetland. ▪ Indigenous lilies, reeds *(Phragmites* sp.), grass (*Pennisetum macrourum*) were noted. Some black wattles have invaded the wetland.	wetland marsh	Berg				MODERATE - plays a polishing role within catchment; quite a few indigenous species; limited alien species, therefore provides relatively good habitat
Low route 14	Wetland on northern side of Klapmuts Road	▪ This site comprises a wetland patch supporting the bulrush, *Typha capensis*, *Phragmites* reed and *Pennisetum* grasses. It is fed by water leaked from a dam on the southern side of the road. A small channel carries water from the dam through a culvert under the road and into the wetland. ▪ Some aliens such as *Acacia saligna* and pines have invaded the wetland to a certain extent.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size.
Low route 15	Wetland on northern side of Klapmuts Road	▪ Same type of habitat as described for Low route 14 above.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size.
Low route 17	Stream h, flowing through Klapmuts	▪ This is a grassy channel, dry at the time of the site visit. Channel is approx. 5m wide and banks are steeply incised and 2m high. ▪ Vegetation is all alien species such as	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		poplars, pines, acacias, kikuyu grass.						
High route 2	Waterval River, below Dasbos Tunnel outlet	▪ See Low route 2 above	foothill cobble-bed stream	Berg	C	D	HIGH	
High route 34	*Pennisetum* marsh, Graham Beck wine farm	▪ This marsh is situated along the edge of the vineyards at the eastern boundary of the farm. ▪ The marsh has been invaded by alien acacias.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size and infestation of alien acacias
High route 32	Grassed wetland, Graham Beck wine farm	▪ This grassed wetland was a shallow dam a few years ago, but is now a seasonally wet sandy area which is heavily grazed. ▪ The wetland is dominated by the indigenous wetland grass, *Pennisetum macrourum*., and also overgrown with kikuyu. Acacias and gum trees have invaded the wetland. Some terrestrial species are establishing here.	wetland marsh	Berg				LOW / MODERATE - fairly extensive *Pennisetum* seasonal wetland habitat but impacted by grazing and severely manipulated in the past
High route 35	"Bellingham Stream", upstream of Low route 1, and downstream of High route alternative 30, Graham Beck wine farm	▪ The channel is approx. 3m wide, with riffle-pool sequences and a cobble and mud substrate (as a result of upstream erosion of banks and sedimentation). There was little baseflow at the time of the site visit (i.e. end of summer). Banks are largely modified. ▪ Water quality appears relatively poor, as evidenced by large quantities of algae on the stream bed. ▪ Riparian belt is infested with alien acacias and herbaceous understorey. Indigenous sedges (including *Juncus* sp.) and alien kikuyu grass were also recorded on the	foothill cobble-bed stream	Berg	**D**	**E**	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		river banks.						
High route 31	Graham Beck Stream, Graham Beck wine farm	▪ See Low route 31 above	foothill cobble-bed stream	Berg	C	D	MODERATE	
High route 5	Stream b, on L'Ormarins	▪ Stream appears to be very similar to Stream a, described for Low route 3 above.	foothill cobble-bed stream	Berg	D	D	MODERATE	
High route 4	Stream a, upstream of Low route 3	▪ Same as Low route 3, above	foothill cobble-bed stream	Berg	D	D	MODERATE	
High route 6	Dwars River, southern side of Klapmuts Road	▪ See Low route 6 above.	foothill cobble-bed stream	Berg	C	D	HIGH	
High route 7	Stream c, southern side of Klapmuts Road	▪ See Low route 7 above.	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
High route 8	Stream d, southern side of Klapmuts Road	▪ See Low route 8 above.	foothill cobble-bed stream	Berg	D	D	MODERATE	
High route 12	Stream f, Backsberg Farm	▪ This site is located below a farm dam, and is a stream that carries overflow from the dam. The channel is approx. 2m wide. ▪ Stream banks are incised and steep. ▪ The stream channel is invaded by kikuyu grass, acacias, gums and some indigenous olive trees. A swathe of the common reed, *Phragmites* sp., has spread	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		below the dam and within the stream channel.						
High route 11	Channel on Backsberg Farm	▪ Channelised ditch following the edge of a ploughed field. The channel is sandy-bottomed. ▪ Channel is heavily invaded by kikuyu grass. Oaks, pines and some indigenous olives located on the banks of the channel. A wetland fringe is evident next to the channel, with some sedges recorded in the channel itself. Vineyards are planted right up to the edge of the channel.	runoff conveyance channel	Berg				LOW - highly engineered with little wetland habitat and therefore low ecological functioning.
High route 13	Stream g, Klein Simonsvlei	▪ 1m wide muddy stream, which has probably been channelised. ▪ Water quality appears to be relatively good, water is only slightly opaque. Litter was observed in the stream. ▪ Riparian vegetation includes lilies, some sedges (probably *Juncus* sp.), *Persecaria* sp. and *Phragmites* reeds. Alien tree species have invaded the riparian belt, including acacias (black wattle is the dominant species) and eucalypts.	foothill cobble-bed stream	Berg	D	D	LOW / MARGINAL	
High route 16	Channel below dam, east of Klapmuts Road, Backsberg Trust farm	▪ This site has a small stream below a dam. It was completely dry at the time of the site visit. ▪ The site is heavily invaded by the alien tree species *Acacia saligna*. Some *Typha capensis* was recorded in the channel.	runoff conveyance channel	Berg				LOW - no significant wetland/riparian habitat and therefore it has a limited functional role in the catchment
High route 17	Stream h, flowing through Klapmuts	▪ See Low route 17 above.	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
High route alternative	Wetland on Graham	▪ Small stream carries overflow / leaks from a farm dam through a wetland swathe of	wetland marsh	Berg				MODERATE - sedge wetland

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
30	Beck wine farm, upstream of High route 35	grasses and sedges. This area is grazed by sheep, and is regularly mown by the farmer. The wetland swathe is approximately 20m wide, and used to be planted with plum trees. ▪ Water sitting in the wetland is orange as a result of high iron content. The water in the farm dam above this site is unusable for irrigation due to the iron. ▪ The wetland is dominated by at least 2 species of sedge, while the surrounding slopes are grassed with kikuyu and other indigenous species, such as *Pennisetum macrourum*. Some indigenous olive trees, alien acacias and pines are situated at the edge of the wetland.						provides a relatively large area of wetland habitat; fulfils corridor function
High route alternative 31	Graham Beck Stream, Graham Beck wine farm	▪ See Low route 31 above	foothill cobble-bed stream	Berg	C	D	MODERATE	
High route alternative 8	Stream d, flowing through Plaisir de Merle farm	▪ See Low route 8 above.	Foothill cobble-bed stream	Berg	D	D	MODERATE	
Spes Bona to Muldersvlei								
High route 25	Wetland alongside R312	▪ This site is a small buffalo grass wetland which would probably have been a natural drainage line which now has been bisected by the road and reduced to small patches of wetland fed by groundwater. ▪ Some sedges and bulrush were also recorded.	wetland seep	Mosselbank				LOW - although it may provide wetland habitat, this is limited because of its limited size.
High route 28	Mosselbank River, at	▪ This typical wetland transitional river flows along an approx. 6m wide channel, with	wetland transitional	Diep	D	D	MODERATE to HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	nursery alongside R302	a mud and sand bottom. Flow conditions are predominantly slow run. The river might have been channelised here, and the river banks are impacted by cattle trampling and some infilling. It is likely that the river used to braid through an extensive floodplain wetland, but it is now confined to a river channel through grassed flats used primarily for grazing. ▪ Water appears to be of fairly good quality – the water is clear with little evidence of algal growth. ▪ The riparian fringe is dominated by dense stands of *Cyperus textilis* (it is possible that the proliferation of this species is due to the more fixed nature of the river channel which is now probably deeper and more perennial than in the past). Gum trees and black wattle have invaded the floodplain, while indigenous *Phragmites* sp reeds, *Persecaria* sp., lilies and sedges were recorded within and alongside the river channel. Duckweed (*Lemna gibba)* was present on the water surface.	river					
High route 47	Small stream on hillslope	▪ This is a narrow, grassed drainage line flowing in a south-easterly direction under the R302, and into the Mosselbank River. ▪ The banks are eroded, and the riparian belt invaded by alien acacia's (Port Jackson).	Wetland transitional river	Mosselbank	E	E	LOW / MARGINAL	
High route alternative 26	Mosselbank River, adjacent to R312	▪ The river flows under the road to Durbanville and continues northwards towards the Mosselbank River. At the time of the site visit, the stream was fairly dry. The stream has been modified (channelised) by the construction of the road and road bridge. ▪ The stream has a well-vegetated channel, supporting dense stands of the reed,	wetland transitional river	Diep	D	E	MODERATE to HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		Cyperus textilis, *Persecaria* sp., *Rumex* sp., and bulrush. Fairly large individuals of the indigenous olive tree were recorded, while alien riparian trees include poplars, and gum trees. Duckweed, *Lemna gibba*, was observed on the surface of standing water in the channel.						
High route alternative 38	Grassed channel, Patrysfontein	▪ This channel is grassed with kikuyu grass, which is heavily grazed. The banks of the channel are impacted by the trampling of cattle, and through modification of the banks for channelisation. ▪ The water in the channel is highly eutrophic, probably due to runoff from cow fields.	runoff conveyance channel	Mosselbank				LOW - eutrophic channel with poor quality runoff (dam overflow), trampled by cattle and grassed with kikuyu therefore no aquatic habitat
Low route 37	Restio wetland, Patrysfontein	▪ This wetland is dominated by restios and indigenous grasses. It is situated alongside an area cultivated with kikuyu grass for sale.	wetland marsh	Mosselbank				LOW - although it may provide wetland habitat (indigenous restios), this is limited because of its limited size.
Low route 39	Wetland patch, Patrysfontein	▪ This wetland patch is linked with a drainage line that enters two farm dams on the property. ▪ Wetland is dominated by kikuyu grass, and another indigenous wetland grass species (possibly *Cynodon dactylon*). *Acacia saligna* has invaded this area.	wetland seep	Mosselbank				LOW - limited in size with low habitat quality
Low route 40a	Wetland patch, Patrysfontein	▪ This is a small wetland patch in a depression alongside the fenceline drainage channel. It is likely that the wetlands in this area were more extensive in the past, but	wetland seep	Mosselbank				LOW - limited in size with low habitat quality

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		these have been reduced to small patches through artificial drainage of fields for cultivation and grazing. ▪ *Acacia saligna* has invaded the wetland patch and also the drainage line that follows the fence.						
Low route 40b	Fenceline drainage line, Patrysfontein	▪ Drainage line below dam, following fenceline. ▪ Grassed, with a few sedges	runoff conveyance channel	Mosselbank				LOW - poor quality aquatic habitat with no real ecosystem functions
Low route 41	Mosselbank River, on Patrysfontein	▪ This site is upstream of sites 26 and 27 on the same river, described above. The channel has been impacted through infilling, and is approx. 2m wide here. ▪ The stream is dominated by kikuyu, with some indigenous reeds (such as *Cyperus textilis*) and grass species (*Pennisetum macrourum*). *Acacia saligna* is also present.	wetland transitional river	Mosselbank	D	D	MODERATE to HIGH	
Low route 43	Tributary of the Mosselbank River	▪ This river site is upstream of High route 28 described above. Here, the river is a slow, meandering system flowing in multiple channels over a muddy substrate. The grassed floodplain is grazed, and some excavation of sand has damaged the banks. ▪ Water quality appears to be poor. ▪ The riparian belt comprises *Cyperus textilis* and *Phragmites* reeds. Alien *Sesbania* sp. is also evident. Waterlilies have established on the water surface. Waterbirds were observed during the site visit.	wetland transitional river	Mosselbank	E	D	MODERATE	
WTPs and infrastructure								
WTP 18	Wetland on northern side of N1,	▪ This is a grazed wetland patch, with a fine sand and silt bottom. Some flow of water was observed at the time of the field visit. It is	wetland seep	-				MODERATE - large enough to provide

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	Boland District Municipality	likely that the stream leaving the wetland has been channelised in order to drain the wetland area for grazing. Trampling by cattle has destroyed some of the wetland habitat and has modified the stream banks. ▪ Water quality appears relatively good, especially at the downstream edge of the wetland patch. Some algae were recorded in the water. The indigenous but invasive duckweed, *Lemna gibba*., was observed on the surface of the water, an indication of organic pollution. ▪ The wetland supports large stands of sedges (including *Juncus* sp.), bulrush, lilies and the indigenous wetland grass, *Pennisetum macrourum* sp. Kikuyu grass was plentiful within the wetland and surrounding it. *Acacia saligna* has invaded the area.						important habitat, despite highly eutrophic status (cattle trampling); also functions as a corridor
WTP 19	Wetland on Hoopenberg farm, Muldersvlei	▪ This is a fairly large *Pennisetum* wetland patch, which is in a relatively good condition (i.e. fairly unimpacted). Several bird species were observed visiting this wetland. ▪ Some alien willow trees, *Salix babylonica*, were observed here.	wetland marsh	-				MODERATE - large enough to provide important habitat; fairly unimpacted *Pennisetum* wetlands within cultivated area
WTP 48	Wetland seep and stream	▪ Dry at the time of the field visit, but clearly a seasonal seep / stream system. ▪ Grassed and quite heavily grazed.	wetland seep	-				MODERATE - large enough to provide important habitat, and important stream corridor.
WTP 49	Wetland seep and	▪ This is a grassed, and quite impacted stream / seep below a farm dam.						LOW - poor quality aquatic

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	stream, below farm dam							habitat
WTP 50	Wetland marsh between farm dams, alongside N1	▪ The area between two farm dams, is a *Pennisetum* wetland, of good quality. ▪ Was probably a seasonal stream before construction of the dams.	wetland marsh	-				MODERATE - large enough to provide important habitat.
WTP 36	Stream k, south of Bakenrug farm	▪ The stream here was dry at the time of the site visit. This channel drains into an indigenous *Pennisetum*-dominated wetland (with sedges) near the R304, through which the stream meanders. ▪ An indigenous riparian corridor (probably dominated by renosterveld) surrounds the stream further up the hill (where the pipeline will cross), providing an approx. 50m swathe of vegetation, representing an important natural corridor between the vineyards and wheatfields.	wetland transitional stream	Mosselbank	**B**	**C**	MODERATE	

5 APPENDIX 2 COMMENT ON MINOR CHANGES TO ALIGNMENT OF PIPELINE – EMAIL DATED 26TH JUNE 2006

5.1Background

An email received from BKS (from Isak Malherbe, dated 26/06/06) reads as follows:

"Subsequent to the drawings I gave you of the pipelines, we had to make minor changes to the pipeline routes as a result of landowner feedback and in order to avoid sensitive areas. Therefore some additional alternatives, indicated on the attached images (sent in 3 mails because of the size), were added to the drawings.

The location of these sites:

Alt RB1 : Between sites A and B - vineyards
Alt KA6 : Immediately west of Klapmuts - in road reseve
Alt Alternatives: Between Klapmuts and Simondium - on farm Babylonstoren"

The abovementioned sections of pipeline are provided below in Photo's 5.1 – 5.3.

5.2Comment on impacts associated with alternatives

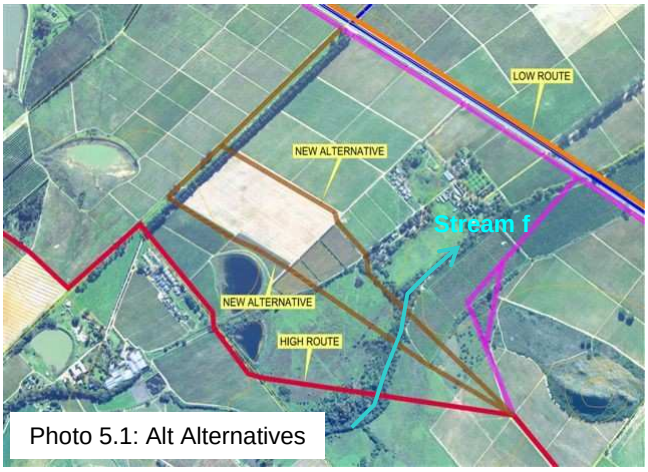

Photo 5.1: Alt Alternatives

5.2.1Alt Alternatives

These alternative routings cross over Stream f on Backsberg Farm. The stream is located below a farm dam, and carries overflow from the dam along a channel approximately 2m in width. The stream is heavily impacted by the surrounding agricultural activities, and is invaded by a number of exotic plant species. The stream was assessed as being of low/marginal ecological importance and sensitivity, and, overall, of low conservation importance. The high route also crosses this stream, thus the impacts associated with this alternative routing are the same as those described for the high route between the Dasbos Outlet and Klapmuts in Section 1.5.3 and assessed in Section 2.4.1.

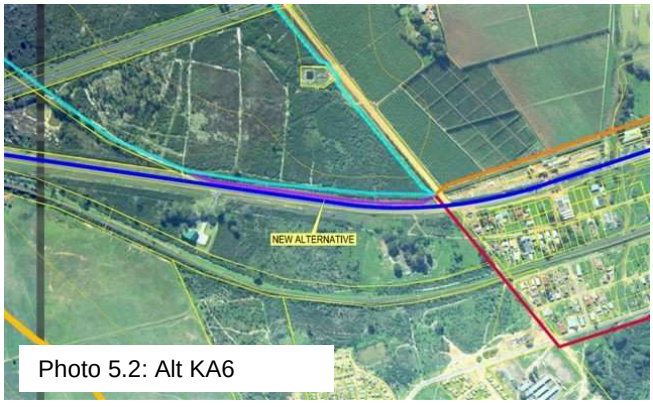

Photo 5.2: Alt KA6

5.2.2Alt KA6

There are no additional impacts associated with this alternative alignment, which makes places the pipeline within the road reserve just west of Klapmuts. The impacts on freshwater ecosystems associated with WTPA and WTPB and infrastructure remain the same as those described in Sections 1.5.8 and 1.5.9 and assessed in Section 2.4.2.

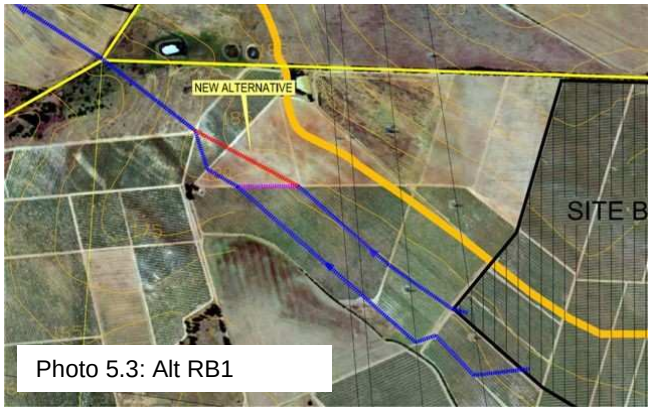

Photo 5.3: Alt RB1

5.2.3Alt RB1

No additional impacts on freshwater ecosystems are associated with this alternative routing, and none are cancelled out. Thus, the impacts associated with WTPB and its infrastructure remain the same as those described in Section 1.5.9 and assessed in Section 2.4.2.