Annexure 9:

Wetland evaluation of Golden Bar Pit and Waste Rock Stack watercourses - Whirika

Wetland evaluation of Golden Bar Pit & Waste Rock Stack watercourses

OceanaGold

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Whirika Consulting
PO Box 1320
Dunedin 9054

Level 3
2 Dowling Street
Dunedin 9016

(03) 742 1093
kiaora@whirika.co.nz
whirika.co.nz

Report prepared for client by Dr Mike Thorsen

Report identifier: 01015-24-241002

2 Dowling Street
Dunedin 9016
New Zealand

kiaora@whirika.co.nz
whirika.co.nz

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Contents

Background

Oceana Gold NZ Ltd (OGL) is seeking consent to undertake various activities within an area known as the Golden Bar (GB) as part of the Macraes Phase IV development project which comprises an extension of the Golden Bar Pit and the associated Golden Bar Waste Rock Stack (GBWRS). Previous work has identified that the affected watercourses contain a mosaic of native and exotic vegetation (termed riparian vegetation) and that parts of these watercourses, and the riparian vegetation within them, are streams for the purposes of the ORC Plan: Water. This investigation looked at the vegetation above the uppermost limit of the identified extent of river (TOR – refer Attachment 1)[1] to determine whether the vegetation is most appropriately classified as a Natural Inland Wetland (wetland) as defined in the National Policy Statement – Freshwater Management, or if not, identifying what is the most appropriate classification for the vegetation.

1 Wetland Delineation

1.1 Definition of natural inland wetland

A 'natural inland wetland' is defined in the NPS FM as a wetland (as defined in the Resource Management Act 1991) that is not:

(a) in the coastal marine area; or

(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or

(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or

(d) a geothermal wetland; or

(e) a wetland that:

(i) is within an area of pasture[2] used for grazing; and

[1] Technical Note 31 May 2024 outlining the approach employed to identify top of river. This came out of a site visit to the Back Road Waste Rock Stack area with ORC staff and Dr Richard Allibone on 24 July 2023

[2] Note: the 2022 amendment no longer contains a definition for 'improved pasture' (as was provided in the 2109 version) and has no definition of 'pasture'. The technical documents imply that pasture must be actively managed rather than maintained by grazing.

(ii) has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8[3])); unless

(iii) the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.

'Threatened species' means any indigenous species of flora or fauna that:

(a) relies on water bodies for at least part of its life cycle; and

(b) meets the criteria for nationally critical, nationally endangered, or nationally vulnerable species in the New Zealand Threat Classification System Manual (see clause 1.8).

The Resource Management Act 1991 defines a wetland as includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions. It defines a water body as fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area. A lake is defined as a body of freshwater which is entirely or nearly surrounded by land. A river is defined as a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).

The bed of a water body is defined in relation to any river as the space of land which the waters of the river cover at its fullest flow without overtopping its banks; and in relation to any lake, except a lake controlled by artificial means, the space of land which the waters of the lake cover at its highest level without exceeding its margin.

1.2 Wetland delineation protocols

The NPS FM is linked to a number of wetland delineation protocols (available at https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/#material-incorporated-by-reference). Additional material is available via links in the references to the Wetland Delineation Protocols document. The following wetland delineation resources were used in the assessment of the GB sites:

- Wetland delineation protocols (MfE, December 2022).
- Wetland pasture assessment methodology (MfE, December 2022).
- National list of exotic pasture species (Mfe, December 2022).

[3] Material incorporated by reference such as the wetland delineation protocols.

- A vegetation tool for wetland delineation in New Zealand (this gives additional detail to the methods in the Wetland pasture assessment methodology) (Landcare Research, December 2013).
- NZ Wetland Plant List 2021 (Manaaki Whenua Landcare Research report LC3975 and associated spreadsheet).
- Wetland delineation hydrology tool for Aotearoa New Zealand (MfE, July 2021).
- Hydric soils – field identification guide (Manaaki Whenua Landcare Research report LC3233, June 2018).

1.3 Sequence and choice of delineation tools.

The Wetland delineation protocol requires first an evaluation of whether the site may fit one of the exclusion criteria including whether the site is in an area being used for pasture and where listed exotic pasture species are likely to cover greater than 50% of the site. The Pasture exclusion assessment methodology is used to decide if the exclusion conditions are met.

If the pasture exclusion conditions are not met, then the site is evaluated using the steps in Figure 2 of the Wetland delineation protocols (replicated below). This delineation protocol involves firstly a rapid hydrophytic vegetation test, and if the rapid test is uncertain then both the dominance and prevalence hydrophytic vegetation tests are used. If the outcome of that analysis is uncertain then both of the hydric soils tool and Wetland hydrology tool are used.

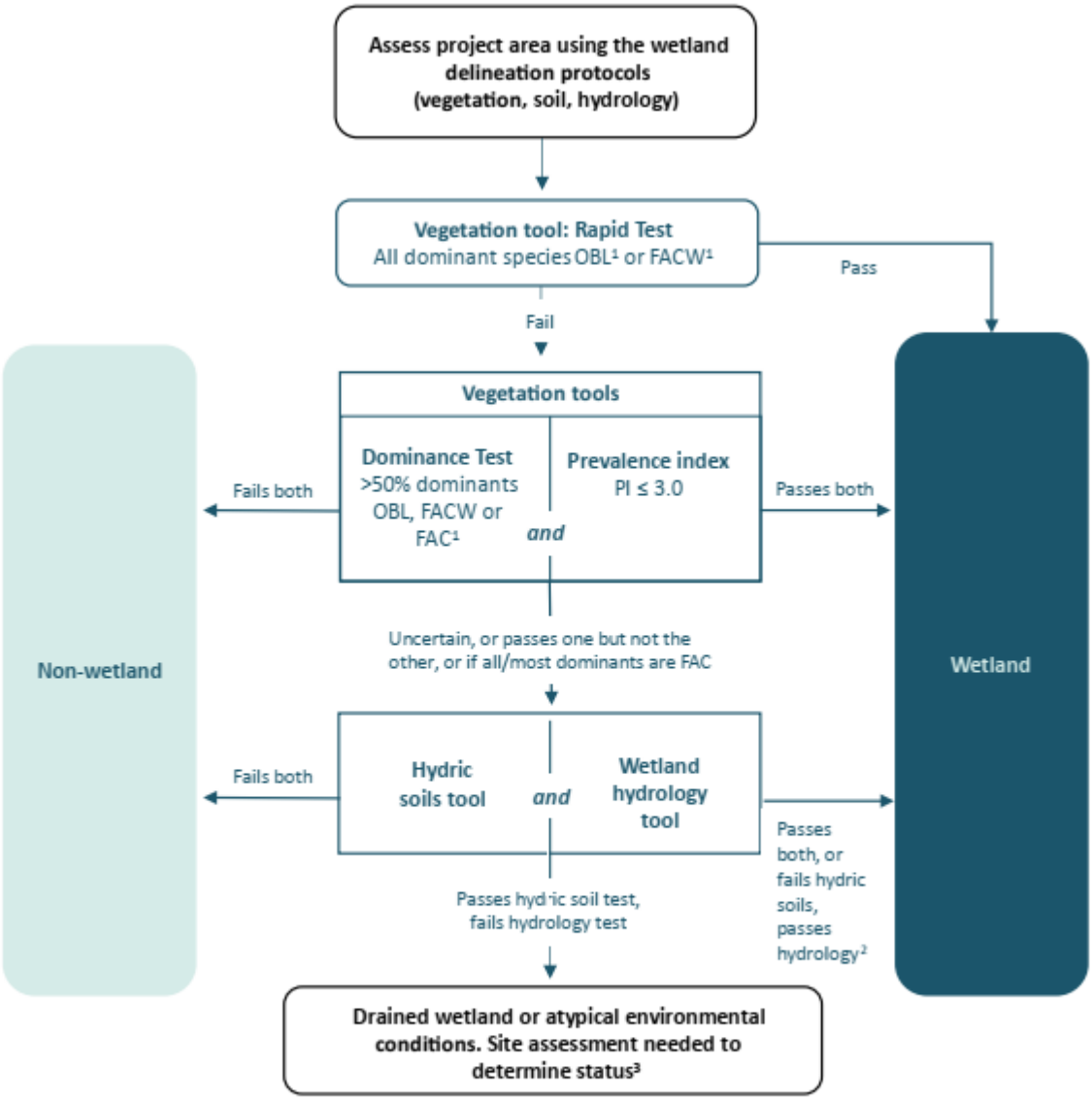
If the site fits the dominance and prevalence tests of a wetland it is classified as a wetland.

If the site fits one of the primary indicators or two secondary indicators of the wetland hydrology tool it is classified as a wetland (irrespective of results of the hydric soils test).

If the site passes the criteria shown in Figure 19 (p. 21) in the hydric soils test, then the site is considered to contain hydric soils indicative of the presence of water (including intermittent water presence).

If the site passes the hydric soils test but fails the hydrology test then further assessment is required and the Wetland Delineation Regional Supplement for the Western Mountains, Valleys, and Coast Region, US (US Army Corps of Engineers, 2010) is recommended by MfE in these situations.

Figure 2: Hydrophytic vegetation determination



Footnotes:
[1] Wetland indicator status abbreviations: FAC = facultative, FACW = facultative wetland, OBL = obligate wetland.
[2] For example, recent wetland.
[3] The US procedures for atypical or problematic situations are recommended.

1.4 Pasture exclusion assessment methodology

The pasture exclusion assessment methodology is carried out by first undertaking a rapid assessment of the site using the steps illustrated in Figure 2 of the methodology and including an assessment of the dominant plant species at the site and their wetland indicator status (see NZ Wetland Plant List 2021 and associated spreadsheet for wetland indicator species). If the site is not clearly pasture or wetland

following this rapid assessment then the approach in Figure 1 (sic, the second Figure 1 on p. 14) of the methodology is used: does the site contain a species listed as Threatened in the NZ Threat Classification System? Does the site meet the Pasture exclusion conditions?[4]

In Figure 1 (i.e. the second Figure 1) a step is employing the pasture exclusion test as detailed on p. 25. This involves quantifying (ideally using vegetation plots) the site coverage by pasture species (P) and the total vegetation cover (TVC, the area of the site covered by vegetation) using the formula *P/TVC x 100 =_____%* with the site being considered pasture if the result of this calculation is greater than 50%.

To assist in consideration of whether the plant species present are considered pasture species, a national list of exotic pasture species is provided. Some plant species are explicitly excluded from the pasture plants list (see p. 9 and 10 of Pasture exclusion assessment methodology).

If the site is problematic then the Wetland Delineation Regional Supplement for the Western Mountains, Valleys, and Coast Region, US (US Army Corps of Engineers, 2010) is used.

If the site is not excluded as pasture, then the next step is to determine if the site qualifies as a wetland by following the steps in the Wetland delineation protocol.

1.5 Rapid vegetation test

The rapid vegetation test consists of visually estimating the percentage of total vegetation cover of all species with a OBL or FACW wetland indicator status. If all species that comprise more than 20% of the total vegetation cover possess a OBL or FACW wetland indicator status then the site can be considered a wetland and no further tests are required.

1.6 Dominance test

The process for assessing the dominance of a wetland by hydrophytic vegetation (plant species indicative of wet environments) involves using the methodology described on pages 27-28 in the Pasture exclusion assessment methodology. This involves summing measures of plant cover representative of the vegetation communities at the site using quantifiable measures based on a suitable plot methodology. The sum of plant cover for all plots and for all vegetation strata over the site is then divided by 5 to produce a 20% cover value. Any species with a plant cover greater than the 20% cover value are categorised as a dominant species and the wetland indicator status for each of the dominant species is assigned. If more than 50% of the dominant species have a wetland indictor status of OBL, FACW or FAC then the site is considered to be dominated by hydrophytic vegetation indicative of it being a wetland.

[4] I note these are required as a first step if following a strict application of the Wetland delineation protocol.

In this assessment, due to the narrow extent of sites being examined, a 50 cm x 50 cm plot divided into a 5 x 5 grid of 25 cm^2 squares was used with the number of squares in which the species is present being used as a relative frequency measure[5]. Plots were randomly situated within the site. This plot sampling method was also used in calculation of the Prevalence Index.

1.7 Prevalence Index

The process for assessing the prevalence of hydrophytic plant species uses the calculation of a Prevalence Index. To calculate the Prevalence Index the cover of the plant species present within the site is estimated using quantifiable measures based on a suitable plot methodology. The wetland indicator status of each of the plant species present is assigned and the total cover of all plant species within all of the species within each of the wetland indictor status categories (OBL, FACW, FAC, FACU, UPL) are summed. The summed values for each of the wetland indicator plant species are then multiplied by an index value (Table 1). The summed index values divided by the sum of all cover values produces the Prevalence Index. If the Prevalence Index is less than or equal 3.0 then the site is considered to be dominated by hydrophytic vegetation indicative of it being a wetland.

Table 1. Index multiplier values using in calculating a site Prevalence Index.

Wetland indicator status category	**Index multiplier**
OBL	1
FACW	2
FAC	3
FACU	4
UPL	5

1.8 Wetland hydrology test

The wetland hydrology tool involves assessing the site against primary and secondary indicators of water presence. If the site meets one primary indicator or two secondary indicators, then it is considered to be subject to hydrological conditions indicative of a wetland.

[5] See Walker, S.J; Mark, A.F; Wilson, J.B. 1995. The vegetation of Flat Top hill: an area of semi-arid grassland and shrubland in Central Otago, New Zealand. NZ J. Ecology 19: 175-194 for description of plot methodology.

The primary indicators are indications of the presence of:

- Surface water.
- Ground water within 30 cm of surface.
- Soil saturation.
- High water marks of flooding or ponding.
- Sediment deposits.
- Drift deposits.
- Algal mats or crusts.
- Iron deposits.
- Surface soil cracks.
- Inundation visible on aerial imagery.
- A sparsely vegetated concave surface.
- A salt crust.
- Aquatic invertebrates.
- Water-stained leaves (also a secondary indicator in areas of high rainfall).
- Hydrogen sulphide odour.
- Oxidised rhizospheres along living roots.
- Presence of reduced iron in soil.
- Recent iron reduction in tilled soils.
- High water table stunted or stressed plants.

Secondary indicators are the presence of:

- Drainage patterns.
- Dry-season water table.
- Saturation visible on aerial imagery.
- Localised depression geomorphic position.
- A shallow aquitard.
- Facultative-neutral test (greater than 50% of the plant species present have a wetland indicator species of OBL or FACW if FAC species are not counted).
- Frost-heave hummocks.

1.9 Hydric soils test

The hydric soils tool involves investigating whether the soils at the site are indicative of soils that form under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic (low oxygen/redox) conditions in at least the upper 30 cm of the soil. The methodology for this assessment is provided in Section 5 on p. 20 of the hydric soils tool. In summary if the soils contain peaty material, greater than 50% of pale low chroma colours and a deeper pan and is saturated for part of the year, features mottles or reddish root channels and/or dark low chroma colours positioned over a horizon of greater than 50% of pale at depths between 30 and 40 cm, then it is likely that the soils are showing characteristics representative of a hydric soil.

1.10 Additional local considerations in applying the wetland delineation tools

These tools need to be used correctly and in the appropriate context. A complicating factor is that some potential wetland sites in the Macraes area are sometimes on shallow soils overlying flat or dipping bedrock and therefore the hydric soils test can be difficult to apply meaningfully. The soils over many parts of Macraes are derived from yellow grey earths that have formed from a loess mantle and are naturally pale and match the low chroma colours in the hydric soils guide. Weathered schist flakes that are present in some soil horizons in this location weather into an iron oxide rich clay and this occurs in both wet and dry soils. The presence of pale soil parent material is acknowledged in the hydric soils test as a difficulty in assessing hydric soils.

The indicators in the wetland hydrology tool will also be met by conditions that are normal in other water bodies and therefore their strength in discriminating a wetland versus another type of water body is unclear.

The national pasture species list is of unknown completeness. Some species, such as kneed foxtail *Alopecurus geniculatus* are described as being introduced to New Zealand as pasture species or are known as pasture species overseas, but are excluded from the pasture species list. Many pasture species at Macraes are also more common in gully bottom situations than on the grazed hillslopes due to the higher moisture, soil fertility and shelter available there.

The wetland plant indicator status is questionable for some species occurring in dryland conditions such as at Macraes. It also does not discriminate vegetation or plant species that occur in other water bodies.

One of the plant species recorded during the site visit has no wetland indicator status assigned in the wetland plants list. This species was assigned a provisional wetland indicator species for this assessment. This species is the native cudweed *Euchiton mackayi* (provisionally assigned a FACU wetland indicator status).

2 Wetland assessment methodology

The wetland assessment methodology applied at Golden Bar (GB) followed that laid out above. The raw data and vegetation assessment are given in Appendix 1, the hydric soil data, assessment and photographs in Appendix 2, the hydrology data and assessment in Appendix 3, and photographs of the site in Appendix 4.

The outcomes from Page vs GWRC[6,7] on how to appropriately perform wetland delineation has not been included in this methodology as no formal assessment of these sites was made of animal species adapted to wetland conditions in line with the definition of wetland in the RMA. No fauna species indicative of wetlands (such as waterfowl or aquatic insects) were informally noted during the assessment.

2.1 Areas being assessed

Three areas at GB are assessed for the possible presence of wetlands using this methodology: the area above TOR in the eastern watercourse (plots 1147 – 1154), the area along the western watercourse (where TOR is indistinct) separated into the induced area (where watercourse has been shifted by the current GB WRS, plots 1165 - 1170) and the remaining natural watercourse (plots 1170 - 1173), and the potential wetland at the head of a silt pond in the bottom of the western gully (plots 1157 – 1163) (Figure 1).

2.2 Rapid assessment

It was unclear from the visual assessment whether the watercourses contain wetlands, but some areas appear to meet some of the criteria and the area immediately upstream of the silt pond visually appears to be a wetland.

2.3 Vegetation plots

The presence of a wetland can be indicated by the overlying vegetation community. To quantify the type of vegetation community at each site in accordance with the MfE guidance[8] and Pasture Exclusion

[6] [202] NZCA 51

[7] See for a synopsis: https://www.al.nz/court-of-appeal-decision-has-significant-implications-for-identification-of-wetlands/

[8] Ministry for the Environment, September 2021. Defining 'natural wetlands' and 'natural inland wetlands'

Assessment Methodology[9], twenty-two 50 cm x 50 cm vegetation measurement plots were semi-randomly established in the watercourses above the upper limit of stream extent (Figure 1). Plots were established at sites along the watercourse where there appeared to be a different type of vegetation. Within each site the plot was randomly located. The number of 25 5 cm x 5 cm sub-squares in which each plant species that is present within the plot occurs was recorded to give each plant species a score out of 25 as a measure of its abundance within the plot. The information on the abundance of plant species within the plot, together with the results of the hydric soils and hydrology investigations were used, as outlined in the Wetland Delineation Protocols, to decide if each plot represents a site that is best classified as a wetland, or not.

2.4 Hydric soils

Hydric soils are soils that have formed in the presence of a high water table, or show signs of a periodically high water table. At each vegetation plot site a soil pit was excavated to 30 cm depth (where possible) and the soil characters of the cut face described in accordance with the Hydric Soils Guide and a photo taken of the soil pit. Recent rains ensured that many areas had visible surface water at the time of inspection.

2.5 Hydrology

Indicators of a wetland hydrology were noted in accordance with the Wetland Hydrology Tool[10]. Recent rains ensured that many areas had visible surface water at the time of inspection.

[9] Ministry for the Environment, 31 October 2022.

[10] Ministry for the Environment, July 2021.

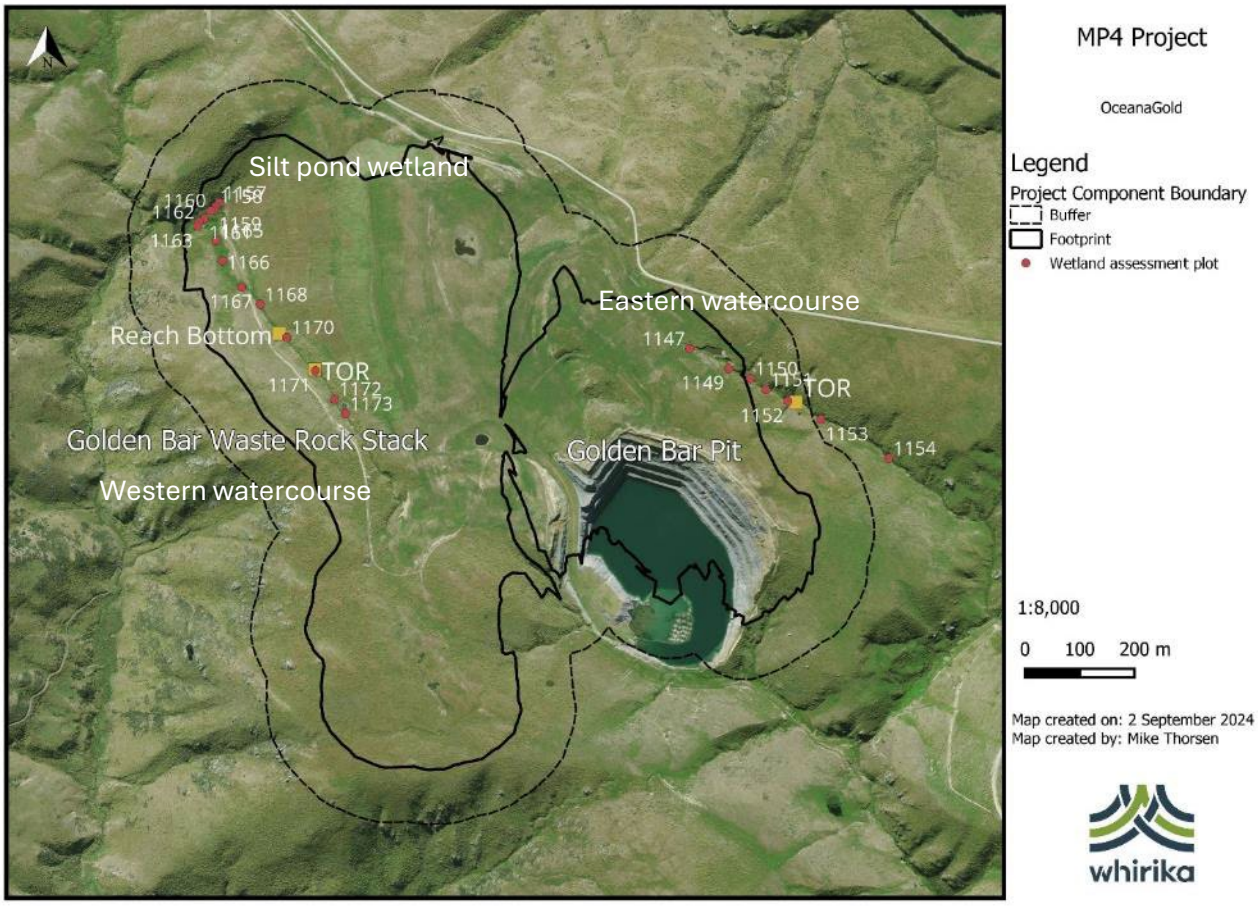


Figure 1. Location of plots used in wetland delineation in Golden Bar. Top of River (TOR) and bottom of natural reach indicated by yellow squares

3 Results

A visual appraisal of the site showed some sites that appear to be wetlands together with other sites that have a higher dominance by exotic species and including pasture species. There is visually little discrimination between the vegetation communities with considerable intermixing. The results in general are discussed here and the designation as Natural Inland Wetland is given in Section 3.8.

3.1 Vegetation

Using the vegetation tools of the wetland delineation protocol, 10 sites fail to meet the definition of Natural Inland Wetlands as they meet the 'pasture exclusion' test, 8 sites qualify as Natural Inland Wetlands under the 'dominance' test, and 8 potentially qualify as a Natural Inland Wetland under the prevalence index test (Table 2, Figure 2).

3.2 Soils

The soils encountered in this method fall into two main groups – deep (20 cm +) moist soils with varying depths of dark low chroma upper horizon loams over an occasionally grey gleyed clay subsoil and/or schist base associated with watercourse bed and shallow (2-5 cm) gravelly melange soils indicative of recent earthworks. The visible moisture content of the deep soils varied between no visible surface moisture, to moist or sodden. No plots qualify as 'hydric soils' and one plot is of uncertain classification using the hydric soils test.

3.3 Hydrology

Fourteen of the assessment plots qualify as wetlands when applying the wetland hydrology test, 12 of these have between 1 and 3 primary indicators of wetland hydrology (mainly surface or subsurface water). Seven assessment plots have 2 secondary indicators of wetland hydrology.

3.4 Threatened species

No Threatened species have been recorded at these sites.

3.5 Results of applying wetland delineation protocols

The results of applying the wetland delineation protocols at the 22 assessment plots were mixed. Eight sites (36%) are classified as representative of wetlands, 10 sites meet the pasture test and 2 have inconclusive results using this approach (Table 2, Figure 2). Overall, the eastern watercourse site meets the 'pasture exclusion' classification with a pasture exclusion score of 0.57 for the induced reach and 0.54 for the natural reach (a score of 0.5 is needed to qualify for the pasture exclusion criteria) and do not meet the dominance test and do not meet the prevalence index test (prevalence index of 4.4 for the induced reach and 3.5 for the natural reach - a value above 3 is classified as not a wetland). The potential wetland at the silt pond is a Natural Inland Wetland (with the caveats explained in Section 3.6) as all plots meet the dominance, prevalence, and hydrology tests. The eastern watercourse above the TOR is more problematic as the plots are a mix of wetland, atypical, not wetland, and pasture exclusion designations and the most appropriate designation for this site is explored further below.

Table 2. Results from applying wetland delineation protocols the 22 plots investigated at GB.

Site	Plot #	Pasture Exclusion	Dominance Test	Prevalence Index Test	Hydrology	Hydric Soils Test	Wetland Plot?	Comments
Silt Pond Wetland	1157	No	Yes	Yes	Yes		Wetland	Disturbed melange soils
Silt Pond Wetland	1158	No	Yes	Yes	Yes		Wetland	
Silt Pond Wetland	1159	No	Yes	Yes	Yes		Wetland	
Silt Pond Wetland	1160	No	Yes	Yes	Yes		Wetland	
Silt Pond Wetland	1161	No	Yes	Yes	Yes		Wetland	Disturbed melange soils
Silt Pond Wetland	1162	No	Yes	Yes	Yes		Wetland	Disturbed melange soils
Silt Pond Wetland	1163	No	Yes	Yes	Yes		Wetland	Disturbed melange soils
Eastern watercourse	1147	Yes	No	No	Yes		Pasture Exclusion	
Eastern watercourse	1149	Yes	No	No	Yes		Pasture Exclusion	
Eastern watercourse	1150	Yes	No	No	Yes		Pasture Exclusion	
Eastern watercourse	1151	No	No	No	Yes		Atypical Environment	
Eastern watercourse	1152	No	No	Yes	Yes		Wetland	
Eastern watercourse	1153	Yes	No	No	Yes		Pasture Exclusion	
Eastern watercourse	1154	No	No	No	No		Not Wetland	
Western watercourse (induced reach)	1165	Yes	No	No	Yes	?	Pasture Exclusion	Disturbed melange soils
Western watercourse (induced reach)	1166	No	No	No	No		Not Wetland	Disturbed melange soils
Western watercourse (induced reach)	1167	Yes	No	No	No		Pasture Exclusion	Disturbed melange soils
Western watercourse (induced reach)	1168	Yes	No	No	No		Pasture Exclusion	Disturbed melange soils
Western watercourse (natural reach)	1170	Yes	No	No	No		Pasture Exclusion	Disturbed melange soils

Site	Plot #	Pasture Exclusion	Dominance Test	Prevalence Index Test	Hydrology	Hydric Soils Test	Wetland Plot?	Comments
Western watercourse (natural reach)	1171	No	No	No	No		Not Wetland	
Western watercourse (natural reach)	1172	Yes	No	No	No		Pasture Exclusion	
Western watercourse (natural reach)	1173	No	Yes	No	No		Uncertain	

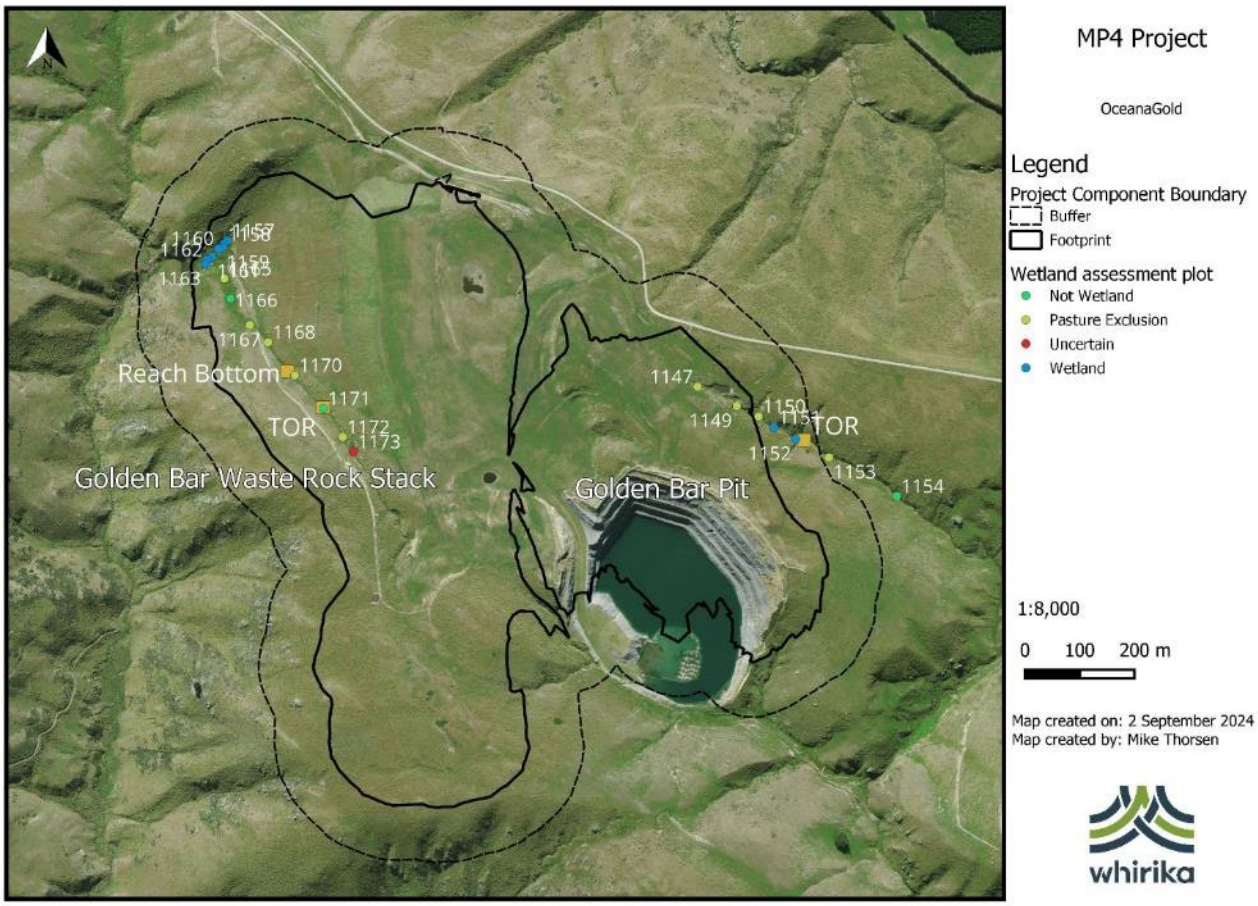


Figure 2. Result of applying wetland delineation protocols at assessment plots at GB.

3.6 Delineation difficulties

The result indicates that the watercourses above the TOR (particularly in the eastern watercourse) are often a mosaic of wet areas and areas with higher coverage by pasture species. This is likely to be at least partly because of several local traits that make applying the wetland delineation protocol difficult in this generally dryland area, and particularly so when looking at watercourse bottoms. Watercourse bottoms in the Macraes area naturally have deeper soils which retain much more moisture and are of higher fertility than the surrounding hill areas and therefore appear green in aerial photographs. A gully landform is one of the secondary hydrology indicators, therefore the sites automatically qualify as meeting the hydrology test requiring fulfilling two secondary indicators. Some of the pasture species listed in the national list of exotic pasture species are more common in the Macraes area in gully bottoms (presumably because of higher moisture, higher fertility, and protection from drying winds) and this makes these sites easier to qualify under the pasture exclusion test. At these sites they often grow with plant species (such as spearwort *Ranunculus flammula*) indicative of very high soil water and at some sites pools of standing water was noted immediately adjacent.

In reality it was almost impossible to differentiate between wetland sites and pasture exclusion sites with some plots that resulted in a 'pasture exclusion' being immediately adjacent to a site that is very obviously a wetland.

3.7 Application of US Army Corps of Engineers Wetland Delineation Regional Supplement for the Western Mountains, Valleys, and Coast Region, US (2010) to the eastern watercourse site

The issue of intermingled vegetation communities such as present in the eastern watercourse is explored in more depth in the US Army Corps of Engineers Wetland Delineation Regional Supplement for the Western Mountains, Valleys, and Coast Region, US (2010) (NZACE) in the section on Riparian vegetation (p. 102), grazing (p 103) and Wetland/Non-wetland mosaics (p. 122). In this case the recommendation is to use close-detail mapping along transects to differentiate wetland from non-wetland vegetation. As there are no reference sites to allow comparison of the eastern watercourse site with natural situations and the vegetation communities in the eastern watercourse are frequently not as distinct as in the NZACE guidelines, the sites are very narrow and twisted ribbon-like (precluding the use of cross-section transects), and multiple sites meet the pasture exclusion criteria, an alternative approach, in which the proportion of plots that meet wetland criteria is used to estimate the proportion of the mosaic that is wetland, is proposed for use in this situation. This results in an estimate that 14% (or ca. 0.008 ha) of the eastern site above the TOR is most appropriately classified as wetland.

3.8 Site wetland status

The recommended designation for each of the sites is:

3.8.1 Silt pond wetland

The silt pond wetland (0.114 ha) is a Natural Inland Wetland (if animals adapted to wet conditions are found to be present) recently created through earthworks associated with mining and where some of the natural values have been established through planting of the sedge *Carex virgata*.

3.8.2 Western watercourse

The western watercourse area comprises an induced section with a new watercourse bed resulting from recent earthworks associated with mining and an orphaned natural reach, neither of which have wetlands present with an indistinct TOR.

3.8.3 Eastern watercourse

The eastern watercourse is a mosaic of vegetation including an estimated 14% above the TOR (ca. 0.008 ha) which qualifies as a Natural Inland Wetland (if animals adapted to wet conditions are found to be present).

4 Effects of project on wetlands

The effects of the GB pit and WRS extension on the vegetation within these sites and how these effects should be managed has been previously assessed (as riparian vegetation) in the MP4 project AEE. The designations provided in Section 3.8 alters this previous assessment in a relatively immaterial way. These changes include a reduction in extent of mapped riparian vegetation in the western watercourse, the presence of an estimated 14% of wetland within the eastern watercourse, and the identified presence of a recently-created wetland above the silt pond.

The effect of MP4 on the silt pond wetland is based on Table 4, Table 5, Table 6 and supporting text in the Environment Institute of Australia and New Zealand (EIANZ) guidelines (2nd Edition, available at http://www.eianz.org/resources/publications). The silt pond wetland is assessed as of **Moderate** ecological value (mostly through the presence of the At Risk – Declining willowherb *Epilobium insulare*[11]. Adverse effects on this wetland cannot be avoided, and there are no opportunities to remedy or mitigate the adverse effects. The magnitude of the impact on wetlands in the local area is assessed as **Negligible** as the site is a recently-created example of a wetland and the level of residual adverse effect overall is assessed as **Very Low**. This level of residual adverse effect is commensurate to 'less than minor' and does not require offsetting or compensation in accordance with the effects management hierarchy.

An effect of this assessment is the identification of the presence of an estimated 14% of wetland (0.008 ha) within the eastern watercourse. This is not considered to affect the Impact Management Plan as the riparian vegetation present in the eastern watercourse is considered to be far less extensive than the riparian areas in the Murphys Ecological Enhancement Area mitigation site, including the likely presence of wetlands as part of a mosaic of vegetation.

5 Loss of river bed

This assessment confirmed the locations previously identified as the top of a river (as defined in the Otago Plan: Water). These locations are shown in Figure 1. The excavation of Golden Bar Pit will not result

[11] de Lange, P.J.; Gosden, J.; Courtney, S.P.; Fergus, A.J.; Barkla, J.W.; Beadel, S.M.; Champion, P.D.; Hindmarsh-Walls, R.; Makan, T.; Michel, P. 2024: Conservation status of vascular plants in Aotearoa New Zealand, 2023. New Zealand Threat Classification Series 43. Department of Conservation, Wellington. 105 p.

in the loss of any riverbed. Deposition of rock into the GB WRS will result in the loss of 95 m of river with a natural bed (the extent between TOR and Reach Bottom in Figure 1) and the loss of 335 m of river with an induced bed resulting from creation of the original GB WRS (the extent between Reach Bottom in Figure 1 and the wetland above the Silt Pond), a total of 430 m of lost riverbed, all of which is in the western watercourse.

6 Conclusion

The most appropriate determination of wetland presence at GB is that a Natural Inland Wetland is possibly present (if animals adapted to wet conditions are found to be present) at the silt pond site. There are also probably limited wetlands present within the eastern watercourse (if animals adapted to wet conditions are found to be present). The correct classification of the eastern watercourse site is likely to be as much a planning decision as an ecological designation. Some sites, or parts of sites, meet the pasture exclusion provisions, and some meet various indicators of a Natural Inland Wetland. There is no clear boundary between these areas and the underlying soil and hydrology would indicate that all of these are of the same type. It is likely that most of the eastern watercourse sites would meet the wetland criteria, unless they have sufficient cover by pasture species to meet the pasture exclusion criteria. Using an adaption of the USACE guidelines provides an estimate of 14% of the area is wetland, some of which is dominated by shrubs, some sedges and some herbfield.

The identity of the remaining non-wetland vegetation above the TOR is problematic. In the past the vegetation community in this situation (including the wetland areas) has been described as riparian vegetation. Ecologically they are strongly associated with water within a gully bottom with little signs of water impoundment creating areas of a high water table characteristic of wetlands (watercourses with a soil bottom will naturally impound water in reaches with shallow gradient). Therefore, the non-wetland community is most likely a gully-bottom vegetation associated with higher soil moisture, shaded, and sheltered from wind and therefore these areas should be considered gully bottom vegetation.

The magnitude of the impact on wetlands in the local area is assessed as **Negligible** as the silt pond site is a recently-created example of a wetland and level of effect overall is assessed as **Very Low**. This level of effect does not require mitigation of effects. In any case, similar environments are contained within the proposed Murphys Ecological Enhancement Area and these environments will be protected and enhanced as a result of offsetting and compensation actions associated with the project more broadly. Considering this, there is to be a net gain in potential wetland values as a result of the project.

A loss of 95 m of natural riverbed and 335 m (430 m) of induced riverbed in the western watercourse will result from deposition of rock into the GB WRS.

Appendix 1: Plot data

Site	Species	Sum of Score	Biostatus	Rating	Plot Total	% Cover	Dominance Test	Pasture Sp.	Pasture Exclusion?	Prevalence Index	Wetland Vegetation
Silt Pond Wetland	Alopecurus geniculatus	78	Exotic	FACW	243	32.1	Yes		No	2.33	Yes
Silt Pond Wetland	Dactylis glomerata	3	Exotic	FACU	243	1.2	Yes	Commercial	No	2.33	Yes
Silt Pond Wetland	Glyceria declinata	2	Exotic	OBL	243	0.8	Yes		No	2.33	Yes
Silt Pond Wetland	Juncus articulatus	47	Exotic	FACW	243	19.3	Yes		No	2.33	Yes
Silt Pond Wetland	Juncus effusus	2	Exotic	FACW	243	0.8	Yes		No	2.33	Yes
Silt Pond Wetland	Scorzoneroides autumnalis	21	Exotic	FAC	243	8.6	Yes		No	2.33	Yes
Silt Pond Wetland	Stellaria alsine	12	Exotic	FACW	243	4.9	Yes		No	2.33	Yes
Silt Pond Wetland	Trifolium repens	22	Exotic	FACU	243	9.1	Yes	Commercial	No	2.33	Yes
Silt Pond Wetland	Carex virgata	50	Endemic	FACW	243	20.6	Yes		No	2.33	Yes
Silt Pond Wetland	Cerastium glomeratum	6	Exotic	FACU	243	2.5	Yes		No	2.33	Yes
Eastern watercourse	Alopecurus geniculatus	25	Exotic	FACW	256	9.8	No		No	3.61	No
Eastern watercourse	Carex secta	10	Endemic	OBL	256	3.9	No		No	3.61	No
Eastern watercourse	Cerastium fontanum	5	Exotic	FACU	256	2.0	No		No	3.61	No
Eastern watercourse	Cynosurus cristatus	70	Exotic	UPL	256	27.3	No	Non-commercial	No	3.61	No
Eastern watercourse	Dactylis glomerata	7	Exotic	FACU	256	2.7	No	Commercial	No	3.61	No
Eastern watercourse	Glyceria declinata	12	Exotic	OBL	256	4.7	No		No	3.61	No

Eastern watercourse	Polystichum vestitum	57	Endemic	FACU	256	22.3	No		No	3.61	No
Eastern watercourse	Stellaria alsine	27	Exotic	FACW	256	10.5	No		No	3.61	No
Eastern watercourse	Trifolium repens	43	Exotic	FACU	256	16.8	No	Commercial	No	3.61	No
Western watercourse (induced reach)	Alopecurus geniculatus	3	Exotic	FACW	200	1.5	No		Yes	4.38	No
Western watercourse (induced reach)	Cirsium arvense	1	Exotic	FACU	200	0.5	No		Yes	4.38	No
Western watercourse (induced reach)	Cynosurus cristatus	40	Exotic	UPL	200	20.0	No	Non-commercial	Yes	4.38	No
Western watercourse (induced reach)	Lolium perenne	30	Exotic	FACU	200	15.0	No	Commercial	Yes	4.38	No
Western watercourse (induced reach)	Prunella vulgaris	1	Exotic	FACU	200	0.5	No		Yes	4.38	No
Western watercourse (induced reach)	Scorzoneroides autumnalis	19	Exotic	FAC	200	9.5	No		Yes	4.38	No
Western watercourse (induced reach)	Trifolium repens	43	Exotic	FACU	200	21.5	No	Commercial	Yes	4.38	No
Western watercourse (induced reach)	Bromus hordaceus	61	Exotic	UPL	200	30.5	No		Yes	4.38	No

Western watercourse (induced reach)	Taraxacum officinale	2	Exotic	FACU	200	1.0	No		Yes	4.38	No
Western watercourse (natural reach)	Agrostis stolonifera	10	Exotic	FACW	145	6.9	No		Yes	3.54	No
Western watercourse (natural reach)	Alopecurus geniculatus	5	Exotic	FACW	145	3.4	No		Yes	3.54	No
Western watercourse (natural reach)	Carex secta	23	Endemic	OBL	145	15.9	No		Yes	3.54	No
Western watercourse (natural reach)	Cerastium fontanum	2	Exotic	FACU	145	1.4	No		Yes	3.54	No
Western watercourse (natural reach)	Cynosurus cristatus	50	Exotic	UPL	145	34.5	No	Non-commercial	Yes	3.54	No
Western watercourse (natural reach)	Dactylis glomerata	10	Exotic	FACU	145	6.9	No	Commercial	Yes	3.54	No
Western watercourse (natural reach)	Juncus effusus	2	Exotic	FACW	145	1.4	No		Yes	3.54	No
Western watercourse (natural reach)	Polystichum vestitum	17	Endemic	FACU	145	11.72414	No		Yes	3.537931	No
Western watercourse (natural reach)	Stellaria alsine	7	Exotic	FACW	145	4.827586	No		Yes	3.537931	No

Western watercourse (natural reach)	Trifolium repens	18	Exotic	FACU	145	12.41379	No	Commercial	Yes	3.537931	No
Western watercourse (natural reach)	Taraxacum officinale	1	Exotic	FACU	145	0.689655	No		Yes	3.537931	No

Appendix 2: Hydric soils results and soil photographs

Plot#	Soil depth (cm)	Peat top 30 cm	Soil >50% low chroma colours	Soil Saturated part year	Soil Saturated all year	Pan present	High water table	Soil mottled orange	Root channels reddish	Dark low chroma colours > 50% cut face	Pale chroma > 50% face at 30-40 cm	Wetland Soils
1147	17									1		
1149	11									1.00		
1150												
1151												
1152	15							1				
1153	10											
1154												
1157	10											
1158												
1159												
1160	30+										1	
1161	10									1.00		
1162	5									1.00		
1163	2							1				
1165	20									1.00	1	
1166	4									1.00		
1167												
1168	20									1.00		

1170	1											
1171												
1172	1											
1173	10									1.00		

6.2 Site 1147

17 cm dark grey organic rich silts and scattered gravel over rock

6.3 Site 1149

11 cm dark grey organic rich silts over rock

6.4 Site 1152

15 cm orange-mottled melange gravel and silts over grey silt/loam

6.5 Site 1153

10 cm cow poo and grey silt loam over rock

6.6 Site 1157

10 cm sodden disturbed gravels and silts/clays/loam

6.7 Site 1161

10 cm dark anoxic silts over rock

6.8 Site 1162

5 cm brown grey loam with roots over 4 cm grey silts over rock

6.9 Site 1163

2 cm damp mottled silts and gravels over rock

6.10 Site 1165

20 cm brown grey silt/loam over pale grey clay/silt with water @ 20 cm

6.11 Site 1166

4 cm brown silt/loam over rock

6.12 Site 1168

20 cm brown grey silt/gravel/loam over rock

6.13 Site 1169

Very shallow soil over rock

6.14 Site 1173

10 cm saturated brown grey loam

Appendix 3: Hydrology result

Plot #	Surface water.	Ground water within 30 cm of surface.	Soil saturation.	High water marks of flooding or ponding.	Sediment deposits.	Drift deposits.	Algal mats or crusts.	Iron deposits.	Surface soil cracks.	Inundation visible on aerial imagery.	A sparsely vegetated concave surface.	A salt crust.	Aquatic invertebrates.	Water-stained leaves (also a secondary [illegible])	Hydrogen sulphide odour.	Oxidised rhizospheres along living roots.	Presence of reduced iron in soil.	Recent iron reduction in tilled soils.	High water table stunted or stressed plants.	Drainage patterns.	Dry-season water table.	Saturation visible on aerial imagery.	Localised depression geomorphic position.	A shallow aquitard.	Frost-heave hummocks.	Primary Indicator	Secondary indicator	Wetland Hydrology?
1147	1																						1			1	1	Yes
1149	1																						1			1	1	Yes
1150	1																						1			1	1	Yes
1151	1																						1			1	1	Yes
1152	1																						1			1	1	Yes
1153	1																						1			1	1	Yes
1154																							1			0	1	No
1157	1	1	1																			1	1			3	2	Yes
1158	1	1	1																			1	1			3	2	Yes
1159	1	1	1																			1	1			3	2	Yes
1160	1	1	1																			1	1			3	2	Yes
1161	1	1	1																			1	1			3	2	Yes
1162	1	1	1																			1	1			3	2	Yes

1163	1	1	1																			1	1			3	2	Yes
1165		1																					1			1	1	Yes
1166																							1			0	1	No
1167																							1			0	1	No
1168																							1			0	1	No
1170																							1			0	1	No
1171																							1			0	1	No
1172																							1				1	No
1173			1																				1				1	No

Site photographs

Eastern watercourse looking downstream from near top

Silt pond wetland. Planted *Carex virgata* to right.

Western watercourse, induced reach below TOR

Western watercourse in orphaned natural area