The Piha Reserves Management Plan was adopted in 1999. This Plan includes the Claude Abel Scenic Reserve and refers specifically (Section 7.3 Claude Abel Reserve) to the management of the pond:

> "...The pond is naturally in-filling and as time passes will become a raupo swamp. This progression is considered desirable and no effort will be made to alter the progression other than hand removal of water lilies".

Since the Management Plan was adopted there has been no management intervention in the pond. However, the local community have recently requested the hand removal of water lilies, as proposed in the Plan, and an amendment to the Management Plan, in order that the pond is preserved as open water habitat for ducks.

4. METHODS

4.1 Vegetation and habitats

An initial site visit was undertaken in May 2004, with a follow-up inspection in June 2004 to assess the present state of the pond and to identify any ecological considerations that should be taken into account when investigating management options. The local environment was also assessed, to determine any wider ecological roles that the pond might have. Broad vegetation communities were delineated on a hard copy aerial photograph and a site map was prepared (refer to Figure 1).

4.2 Fauna

Birds were recorded during the field visits - refer to Appendix 1.

A fish survey was undertaken to investigate the species present in the pond, following WCC fish survey methodology.

Many fish are active at night and in shallow water, it is possible to approach fish closely and to identify and count them. Bank side observations were made using a 55,000 candle power spotlight powered by a 12 volt sealed lead acid battery. This technique is particularly suitable for locating nocturnal indigenous fish in shallow water. The spotlighting survey was conducted from 19:00 to 22:30 hours on 8 July 2004. Two unbaited fyke nets, and eight 'gee minnow' traps baited with fish pellets were used to sample the fish populations in the Claude Abel Pond. The nets and minnow traps were set on 8 July 2004 and retrieved on 9 July 2004.

A habitat assessment was undertaken, and observations were made of stream width, depth, fish cover, substrate, riparian vegetation, and benthic invertebrates. This information was recorded on a NZ freshwater fish database form (Appendix 2).

Fieldwork was carried out in fine, calm conditions on 8 and 9 July 2004. Claude Abel Pond was slightly tannin coloured, a result of recent rainfall earlier in the week. Nevertheless, water clarity was sufficient to enable observations to be made while spotlighting at night.

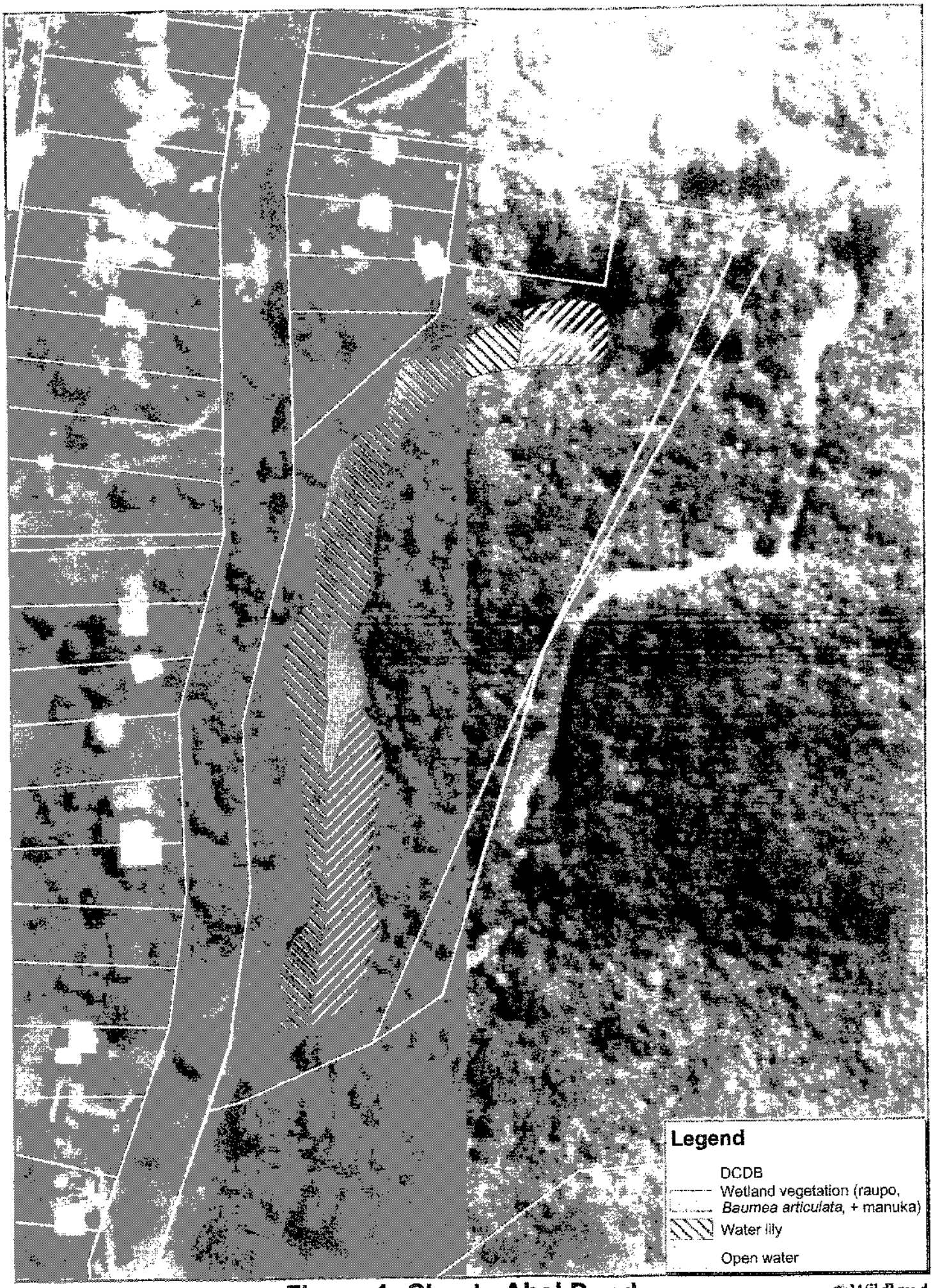

Figure 1: Claude Abel Pond
Waitakere City Council A72

N

0 50 100 m

Wildland Consultants

Scale: 1:1,500
Date: 07/07/04
Cartographer: RPB

4.3 Management options

Investigations were undertaken into works that would require resource consents and any possible issues arising from any physical works at the pond. Relevant staff were consulted at Waitakere City Council and Auckland Regional Council (ARC). Local residents groups were also approached for information on the history of the pond and to gauge their views on future management.

5. HISTORY

Sandra Coney summarised some of the history of the pond in an article in the Piha News. Historically, the site of this pond comprised a natural lake which had formed behind sand dunes, with an associated raupo (*Typha orientalis*)-dominant wetland. By the 1940s raupo had reduced the amount of open water. In 1946 Frank and Fanney Barnett, who lived near the pond, proposed to the then North Piha Ratepayers Association, that the pond should be enlarged by clearing the raupo. Local people undertook working parties to remove raupo and other wetland vegetation, dragging it onto the shore with a winch fitted to a truck. Water lilies (in six colours) were planted in the pond, and fuchsias were planted in ponga posts on the pond margins. Goldfish (*Carassius auratus*) were also introduced and ducks colonised the pond, originally planned for swans. In the early 1960s a mechanical drag line was used to dredge the northern end of the pond. Mud excavated from the pond was deposited along the shore to form a flat area which was then planted with native specimen trees.

Lane Abel (pers. comm.) noted that that "the area of reeds, floating raupo and tea tree at the southern end of the deep pool was purposely left, allowing plenty of privacy and room for the ducks and latterly pukeko to nest and breed".

It is clear that this pond has much historical value attached to it which is reflected in the views of many of the local residents who would like to see the pond maintained as an open water habitat and not left to revert naturally to a raupo-dominant wetland.

6. VEGETATION AND HABITATS

The pond covers approximately 5,100 m^2 with 37 percent of this area having reverted to wetland vegetation dominated by raupo, 53 percent of the pond is covered with water lily, and approximately 10 percent of the pond is open water habitat.

There is well-developed vegetation on the northern and eastern sides of the pond. These comprise a mixture of pohutukawa (*Metrosideros excelsa*) forest, kanuka (*Kunzea ericoides*) forest and kanuka-cabbage tree (*Cordyline australis*) forest. Further inland, to the east, the vegetation comprises windswept kanuka forest on exposed hillslopes. To the south the wetland vegetation is dominated by raupo with scattered manuka (*Leptospermum scoparium*). To the west the vegetation is mostly kikuyu (*Pennisetum clandestinum*) grassland with scattered native specimen trees and is maintained as an amenity area.

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The common water lilies in New Zealand are *Nymphaea alba* (white water lily) and *N. mexicana* (Mexican water lily) (Johnson and Brooke 1989). There is a wide variety of flower colour amongst cultured hybrids of *Nymphaea* species (Coffey and Clayton 1988). It is normally found growing in up to 2 m depth in muddy substrates and has either submerged creeping rhizones or short, erect, tuberous buried stems (Coffey and Clayton 1988).

7. FAUNA

7.1 Aquatic fauna

No fish were observed or captured in the field survey of the Claude Abel Pond. The New Zealand Freshwater Fish Database (NZFFD) contained two records for Claude Abel Pond. Goldfish or morihana (*Carassius auratus*) were reported in a survey carried out in 2002 by the Department of Conservation. In the wild, this introduced species reverts quickly to a natural colouration (bronze/olive) and becomes smaller and secretive in habit. Goldfish are common and widely distributed throughout New Zealand. No fish were captured in a survey undertaken in 2001.

The absence of native fish from Claude Abel Pond is almost certainly attributable to the absence of a surface outflow from the pond to the sea. Most native fish require access to and from the sea to complete their life cycles. Fish distribution and abundance in any pond, river or stream system is therefore dependent on the ability of each species to negotiate obstacles to upstream and/or downstream migration. Given the absence of a surface outflow to the sea, if species other than eels (*Anguilla spp.*) are present they are likely to be very low in numbers. Eels (*Anguilla spp.*) are known for their ability to migrate over land during rainfall events and therefore they may be present in low densities in Claude Abel Pond.

Fisheries values of the Claude Abel Pond are low, therefore any works undertaken in the pond will have minimal affect on fisheries values. If an excavator is used to remove sediment and vegetation from the pond it is possible that some eels may be moved. If sediment is deposited adjacent to the pond to dewater, then eels will quite often find their own way back into the pond. Nevertheless, contractors should be prepared to assist eels (and any other fish) back into the pond if required.

7.2 Avifauna

Bird species utilising the pond include Muscovy duck, mallard duck, and pukeko (refer to Appendix 1). Pukeko usually inhabit marshy areas rather than open water. The dense water lily infestation has provided ideal habitat for pukeko. Muscovy duck and mallard duck require open water with an adjacent area of terrestrial habitat, such as the grassed area in the reserve, where they can roost, preen, and obtain food provided by visitors. These species generally nest between July and December. Any works should be undertaken following the breeding period once all chicks have fledged. February to April is probably a good time to undertake works to minimise disturbance to breeding birds. The pond level may also be lower at this time of year.

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8. SEDIMENT

Sedimentation is a natural process caused by the influx of sediment and deposition of this sediment. Sedimentation is a common process in wetlands, ponds, and lakes and is occurring in the pond. A visual assessment of the sediment present within the pond identified that sand is the major component, with some fine silt and decomposed vegetative matter.

8.1 Sediment sources

Sand was evident around most of the site, including several small drifts amongst the grassed area of the reserve, and on the margins of Garden Road. It appears that sand is wind blown from North Piha beach and associated sand dunes by the prevailing westerly winds. The pond is located 200-300m from the top of the dunes adjacent to North Piha Beach. There is a small consolidated rear dune with several houses between North Piha beach and the pond. Wind blown sand is likely to be washed into the pond during rainfall events rather than simply being deposited directly into the pond, although some direct deposition will occur.

The fine silt present in the pond is likely to originate from runoff from adjacent land, while the decomposed vegetative matter is likely to comprise mostly dead water lily vegetation with a component from the surrounding riparian and wetland plant communities.

8.2 Minimising sediment input

An intact vegetation cover on surrounding land and inflowing catchments is usually the most effective way of reducing sediment loads through runoff. Adjacent vegetation is described above, and most of the contributing catchment has a reasonably intact vegetation cover.

Garden Road is situated to the west of the pond and it was noted that there was no kerb and channel present, allowing runoff to flow onto the adjacent reserve or, in one location, directly into the pond. There is scope for installing a kerb and channel, or a swale adjacent to Garden Road, however, the effectiveness of these measures in reducing overall sediment input into the pond would be minimal, given the relative area of the road compared to the area of the contributing catchment.

8.3 Sediment removal options

There are several options for removal of sediment depending on the volume of sediment to be removed. The amount of sediment to be removed will most likely be determined by cost.

A resource consent will be required from Waitakere City Council as this pond is within the coastal management zone and is covered under the Piha Reserves Management Plan. This consent will most likely require public notification as there is no scope for earthworks or mechanical vegetation removal in the existing management plan.

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A long-reach excavator will be required as machine access is only possible along the western margin of the pond. A temporary Geotech road would need to be established to minimise damage to the existing turf.

It would be beneficial to dewater any dredged sediment on site, prior to carting away for disposal as clean fill, possibly in Waitakere City or Auckland Regional Council Parks. Previous material dredged from the pond was buried in a local ARC car park. Liaison with a contractor on site would need to be undertaken to see if this is possible given the restricted access at the site and the amenity value of the reserve, including avoiding damage to existing specimen trees. Cartage contractors have specified that material must be of a "spadeable" consistency for cartage off site.

Long-term sediment removal programmes will depend on the level of sediment entering the pond, which will be related to weather and storm events. It is suggested that sediment removal be undertaken as required. This would require defined parameters for determining when excavation was required, e.g. when the excavated area of the pond has an average depth less than 2.0 m.

The pond is located in a Scenic Reserve and the Department of Conservation will need to approve any works, in writing, prior to these being undertaken.

8.4 Sediment testing prior to removal

Sediment tests were undertaken to determine suitable disposal channels. Sediment samples were taken from the pond and forwarded to Watercare Services Ltd. Laboratory staff undertook a standard metals scan to measure the concentrations of a wide range of metals, including zinc, copper, and lead. The results were forwarded to the ARC's Land and Water Quality Department for assessment. ARC subsequently issued a letter confirming this sediment will meet the ARC's definition of cleanfill, and is therefore able to be disposed to any suitably authorised local cleanfill operation, once dewatered (R. Cleghorn, ARC, pers. comm., 20 July 2004).

8.5 Costs

WCC resource consent costs	Minimum of $650
ARC resource consent costs for a permitted activity	No charge
Machine and operator costs (Smith & Davies)	$900 transport and demobilise; $135 per hour
Disposal costs - cartage - Piha to The Concourse	$18.40/tonne
Disposal costs - tipping fees - The Concourse	$85/tonne

9. WATER LILIES

9.1 Current situation

Water lilies dominate most of the surface of the existing pond, with several small clear areas, one of which appears to have been maintained by small scale hand clearing near the park bench, probably by local residents.

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9.2 Previous control work

Previous control works have included hand control of the water lilies and some mechanical dredging, although specific details regarding these operations have not been located to date.

9.3 Management options

There are various options for the future management of water lilies at this site: do nothing, undertake hand removal, treat with a gel herbicide, or excavate using a suitable machine. These options are discussed further below, along with an assessment of the strengths and weaknesses of each approach and an assessment of the effects of each option. If excavation is undertaken it would need to attain a depth of 3 m, to avoid re-establishment of raupo. This depth would also preclude the re-establishment of water lily which needs water depth less than 2 m. It should also be noted that excavation options are limited by access. Long-reach excavators can only excavate out to *c.*15 m.

10. MANAGEMENT OPTION 1 - DO NOTHING

About 37 percent of the pond has infilled with raupo and most of the balance is covered with water lilies. This option will probably result in all of the pond (subject to water depth) becoming infilled with raupo.

Brief Description of Option

Option 1 involves taking no action.

Consents Required, and Costs (if any)

No consents or costs will be required.

Ecological Impacts

- Exclusion of all open water habitat resulting in decreased habitat for bird species requiring open water habitat (i.e. mallard and Muscovy ducks).
- Impacts on indigenous species are likely to be positive with the spread of wetland vegetation as the pond naturally continues to infill.

Cost Estimates for Physical Works

This option would not involve any cost but is likely to incur ongoing criticism from local residents and users.

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Advantages

- Nil cost.
- No disruption to residents from control operations.
- Natural in-filling will continue and wetland vegetation (mostly raupo) will continue to advance.

Disadvantages

- Loss of open water habitat and amenity value of the pond.
- Loss of historical values.

11. MANAGEMENT OPTION 2 - HAND CONTROL

This option involves the hand removal of water lilies, as allowed for in the Piha Reserves Management Plan. This will maintain approximately 50% of the original pond as open water (area currently infested with water lily), with infilling and wetland advance continuing in the future as detailed in management plan.

Waitakere City Council Parks obtained an estimate from Techscape Ltd in May 2004 for the hand removal of water lilies from the pond. It was reported that the required works would take several months and Techscape Ltd were not prepared to undertake the work at that time. Techscape staff reported that the pond was a significant depth (above wader height) and that water lilies are very heavy and difficult to hand remove (Penny Davis, Techscape, pers. comm.). Due to the depth of water and weight of the lilies other control options were investigated. An estimate of the works required was $45,000-$55,000 for a 12 week control programme. This would involve a supervisor on the bank on standby with a safety line and two teams of two working in the pond hand pulling/cutting the lilies. This estimate was calculated on the basis that a team of two could remove 20 m^2 of water lilies per day.

Any vegetation removed from the site will need to be disposed of off site. The Transfer Station at The Concourse will take vegetation (with some sediment present) if it is not too liquid, at $85/tonne. Under current weed hygiene and biosecurity measures, special consent is not required for the disposal of water lilies off site.

Another option would be to engage community groups to undertake or assist in the hand removal of the water lilies.

It is proposed that the area currently choked with water lilies is the area to be maintained as an open water habitat. The wetland to the south should remain as habitat for indigenous species, along with the small area of raupo in the northern extent of the pond. The raupo in the northern end of the pond could not be reached by a machine without destruction of riparian vegetation, or complete drainage of the pond to allow access to this area, which is not recommended.

As eradication of water lilies from the pond is unlikely, and it appears residents want to maintain some water lilies, ongoing maintenance/control will be required. The

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extent of the area of the pond to be maintained as an open water habitat will need to be confirmed with stakeholders prior to undertaking any control works.

Ecological Impacts

Hand removal of water lilies is unlikely to have any significant ecological impacts. It is likely that some disturbance to the pond substrate will occur, resulting in discoloration of the water. This, however, is likely to be short term until the sediment settles.

There will also be some minor short term impacts on local fauna populations. Birds will leave the immediate area of works while works are underway, returning soon after. The pond is classed as 'off-line', that is, there is no waterway flowing from the pond (Graham Leonard, Ecowater, pers. comm.) so there will be no effects on other waterways. It is understood the water flowing from this pond dissipates through the sandy substrate.

Health and Safety

Due to the relatively deep water and the weight of the water lily vegetation, health and safety will be a major factor in a hand control operation. Deep water poses a significant hazard, compounded by working amongst heavy wet vegetation. When working in water, work should be undertaken in pairs and a capable, responsible person should remain on the pond bank with a safety line, should any person get into difficulties. High visibility vests should always be worn when working in water. Health and safety hazards may exclude the use of community groups in the control operation.

It is recommended that the pond level be lowered through pumping prior to any control work.

Resource Consents

The Piha Reserves Management Plan, which encompasses the Claude Abel Reserve allows for the hand removal of water lilies. Therefore no resource consent would be required for undertaking hand removal.

Consents Required and Costs (if any)

No consents would be required as hand control is permitted under the Management Plan.

Ecological Impacts

- Hand removal of water lilies will have minimal ecological effects. Some temporary discoloration of pond water would be expected during and following control operations as sediment is stirred up by activity in the pond.

- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.

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- Positive impact on ducks as this will increase their preferred habitat.

Cost Estimates for Physical Works

Hand removal has been estimated between $45,000 and $55,000, with works conducted over a 12 week period.

Advantages

- No resource consents are required.
- Minimal ecological impacts.

Disadvantages

- Labour intensive and therefore costly.
- Health and safety issues with working around deep water and heavy vegetation.
- Community involvement complicated by health and safety considerations.

12. MANAGEMENT OPTION 3 - HERBICIDE

Brief Description of Option

It is feasible to use a herbicide to control water lilies. The most likely option is Glyphosate with a surfactant additive. Herbicide could be applied using a knapsack, a gunspray unit, or from a helicopter (not recommended). It is likely that several applications of herbicide will be required to control the water lilies.

Aqua Ag Ltd provided an estimate and methodology for undertaking herbicide control of the water lilies. Water lilies would be controlled in two stages, with half the infestation treated initially, followed by a second application approximately five weeks later. This is to ensure that the pond has sufficient time to re-oxygenate between herbicide applications.

Herbicide (Roundup G2 @ 3% plus Pulse @ 100 ml per 100 litres water) would be applied by handgun from an Amphibian Airboat. Aqua Ag recommends that the best time for herbicide application is between November and February. To achieve effective control, two herbicide applications are necessary per season, approximately five weeks apart, with follow up applications for three subsequent seasons.

Dredging may be undertaken one month following the second herbicide application. Dredging to maintain a water depth of 3 m is likely to reduce the incidence of re-infestation.

Resource Consents

Herbicide control of water lilies using Glyphosate is likely to be a Permitted Activity under Auckland Regional Council consent conditions. ARC Consents will need to be

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contacted with details of works to be undertaken to confirm whether works are a Permitted Activity. There is no charge for a Permitted Activity consent.

Ecological Impacts

- Following herbicide control, decomposing vegetation will de-oxygenate the pond water. To reduce this, control operations will be staged approximately five weeks apart to allow the pond to re-oxygenate between operations.
- Temporary noise disturbance during herbicide application.
- Positive impact on ducks as this will increase their preferred habitat.

Cost Estimates for Physical Works (Aqua Ag Ltd)

Initial control operation (first half on infestation)	$5,436
Initial control operation (second half on infestation)	$4,036
Follow up control operations (as required) (per operation)	$4,036

Advantages

- Herbicide application is relatively safe compared with hand control.
- Herbicide application will create minimal disruption to local residents

Disadvantages

- Temporary noise disruption to local residents during herbicide application
- The amenity value of the pond will be temporarily reduced while the water lilies die back following the control operation.
- Follow up control will be required for three years following initial control operations to achieve successful control.

13. MANAGEMENT OPTION 4 - MECHANISED EXCAVATION

The pond is in the coastal zone, in a scenic reserve, and falls under the ambit of the Piha Reserves Management Plan and mechanical removal of water lilies (e.g. with a long reach excavator) will require a resource consent from Waitakere City Council for the removal of any vegetation, and undertaking any earthworks (the use of an excavator will also remove sediment along with the vegetation).

A resource consent could include a condition that regular maintenance works (i.e. every five years) can be undertaken without requiring further resource consent applications (Karen Pegrume, WCC Consents, pers. comm.).

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A straight forward resource consent for a permitted activity will cost a minimum of $650 if all information required is provided at time of submission. A resource consent application is likely to be notified, which will increase these costs depending on the level of consultation required. If a project is deemed to be charitable, grants can be applied for to cover consent costs. ARC resource consent is not required in this case as the pond is artificially constructed and is considered an 'off-line' pond, i.e. not part of a stream/wetland system (Marcus Bird, Babbington & Associates – Consultant to ARC Consents, pers. comm.).

Costs

Resource consent costs (ARC, WCC)	Minimum of $650
Machine and operator costs (Smith & Davies)	$900 transport and demobilise; $135 per hour
Disposal costs - cartage - Piha to The Concourse	$18.40/tonne
Disposal costs - tipping fees - The Concourse	$85/tonne

The extent of the pond to be maintained as open water will determine the actual costs of removal, and the costs of any maintenance/future control operations required.

14. MANAGEMENT OPTION 5 - ONE-OFF MECHANICAL REMOVAL OF WATER LILIES WITH REGULAR MAINTENANCE BY HAND

Brief Description of Option

This option would involve using a long reach excavator to remove water lilies and their roots from the pond. Some sediment will also be removed during this process. A five-yearly maintenance programme of hand control of water lilies could be established. This option will result in maintaining approximately 50% of the original pond in open water (area currently infested with water lily), depending on access for an excavator, with infilling and wetland advance continuing in the future as detailed in the management plan.

Consents Required, and Costs (if any)

- Vegetation removal consent - Waitakere City Council.
- Earthworks consent - Waitakere City Council.

These consents will be notifiable as there is no allowance for mechanical removal of vegetation or earthworks under The Piha Reserves Management Plan.

Ecological Impacts

- Mechanical removal of water lilies will have some ecological effects within the pond. Some temporary discoloration of pond water is to be expected during and following control operations as sediment is stirred up by earthworks within the pond.

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- There will also be some minor short term impacts on local fauna populations. Birds will leave the immediate area of works while works are underway, returning soon after.

- There will also be some noise issues with regard to operations of machinery and trucks coming and going.

- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.

Cost Estimates for Physical Works

Machine and operator costs (Smith & Davies)	$900 transport and demobilise; $135 per hour
Disposal costs - cartage - Piha to The Concourse	$18.40/tonne
Disposal costs - tipping fees - The Concourse	$85/tonne

Advantages

- Relatively quick and safe removal of water lilies, including root structures.

- Will also remove some sediment.

Disadvantages

- Will create temporary discoloration of the water as sediment is stirred up.

- Impact on local residents with regard to noise and truck traffic.

- No long term control on the natural infilling and advancement of wetland vegetation.

- Cartage and disposal of sediment will be required.

15. MANAGEMENT OPTION 6 - MECHANICAL REMOVAL OF WATER LILIES WITH REGULAR MAINTENANCE BY MACHINE

Brief Description of Option

Option 6 involves using a long reach excavator to remove water lilies and their roots from the pond. Some sediment will also be removed during this process. A five-yearly maintenance programme of machine control of water lilies and minor dredging could be established. This option will result in maintaining approximately 50% of the original pond in open water habitat, depending on access for excavator.

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Resource Consents Required and Costs (if any)

- Vegetation removal consent.
- Earthworks consent.

Consents would be notified as there is no provision for mechanical removal of vegetation or earthworks under The Piha Reserves Management Plan.

Ecological Impacts

- Mechanical removal of water lilies will have some ecological effects within the pond. Some temporary discoloration of pond water is to be expected during and following control operations as sediment is stirred up by earthworks within the pond.

- There will also be some minor short term impacts on local fauna populations. Birds will leave the immediate area of works while works are underway, returning soon after.

- There will also be some noise issues associated with the use of an excavator and trucks.

- Temporary disruption to access and amenity value of reserve while excavated material is stockpiled prior to cartage.

Cost Estimates for Physical Works

Machine and operator costs (Smith & Davies)	$900 transport and demobilise; $135 per hour
Disposal costs - cartage - Piha to The Concourse	$18.40/tonne
Disposal costs - tipping fees - The Concourse	$85/tonne

Advantages

- Relatively quick and safe removal of water lilies, including root structures.

- Will also remove some sediment.

- Will provide some long term control on the natural infilling and advancement of wetland vegetation.

Disadvantages

- Will create temporary discoloration of the pond as sediment stirred up.

- Impact on local residents with regard to noise and truck traffic.

- Cartage and disposal of sediment will be required.

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- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.

16. MANAGEMENT OPTION 7 - MECHANICAL REMOVAL OF WATER LILIES, SEDIMENT AND SOME WETLAND VEGETATION

Brief Description of Option

This option involves using a long reach excavator to remove water lilies and their roots from the pond. Some sediment and wetland vegetation will also be removed to extend the existing open water pond. A five-yearly maintenance programme of machine control of water lilies and minor dredging could be established. From historical anecdotes it appears that raupo has been present for a long time at the southern and northern ends of the pond, but that the extent has varied.

Resource Consents Required and Costs (if any)

- Vegetation removal consent.
- Earthworks consent.

Consents would be notified as there is no allowance for mechanical removal of vegetation or earthworks under The Piha Reserves Management Plan.

Ecological Impacts

- Option would result in the destruction of some wetland vegetation which is inhabited by various indigenous species.

- Mechanical removal of water lilies will have some ecological effects within the pond. Some temporary discoloration of pond water is to be expected during and following control operations as sediment is stirred up by earthworks within the pond.

- There will also be some minor short term impacts on local fauna populations. Birds will leave the immediate area of works while works are underway, returning soon after.

- There will also be some noise issues with the use of machinery and trucks.

- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.

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Cost Estimates for Physical Works

Machine and operator costs (Smith & Davies)	$900 transport and demobilise; $135 per hour
Disposal costs - cartage - Piha to The Concourse	$18.40/tonne
Disposal costs - tipping fees - The Concourse	$85/tonne

Advantages

- Relatively quick and safe removal of water lilies, including root structures.
- Will also remove some sediment.
- Will provide some long term control on the natural infilling and advancement of wetland vegetation.
- Will increase extent of open water habitat.
- Will maintain historical values.

Disadvantages

- Will create temporary discoloration of the pond as sediment stirred up.
- Increased impact on local residents with regard to noise and truck traffic due to increased level of works.
- Cartage and disposal of increased volumes of sediment will be required.
- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.
- Increased costs due to larger volumes of material to be removed.

17. MANAGEMENT OPTION 8 - RETURN POND TO ITS 'ORIGINAL' STATE

Brief Description of Option

Option 8 involves removing all wetland vegetation and dredging of the pond to re-create what the pond was like when first constructed, although there is no clear evidence of exactly what the pond looked like, or the extent of it. From historical anecdotes it appears the raupo at the southern and northern ends of the pond was always there in the past.

Resource Consents Required and Costs (if any)

Consent to undertake activities not permitted under the current management plan would be required. This would need to be notified consent. Proposed tasks would

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include removing all water lily and wetland vegetation, and dredging the majority of the pond to maintain a large area of open water.

Ecological Impacts

- This option would result in the destruction of wetland vegetation which is inhabited by various indigenous species.
- Aquatic pond life would be disrupted and habitats destroyed by large scale earthworks.
- Important sediment habitats will be removed from the pond
- Mechanical removal of water lilies will have some ecological effects within the pond. Some temporary discoloration of pond water is to be expected during and following control operations as sediment is stirred up by earthworks within the pond.
- There will also be some minor short term impacts on local bird and eel populations. Birds will leave the immediate area of works while works are underway, returning soon after.
- There will also be some noise issues with regard to operations of machinery and trucks coming and going.
- Temporary disruption to access and amenity value of reserve while removed vegetation is stockpiled prior to carting away.

Cost Estimates for Physical Works

This option would be prohibitively expensive due to the huge volume of vegetation and sediment which would need to be excavated and removed from the site.

Advantages

- Returns character of the pond to what it was originally – a large open water pond, reflecting the historical values of the site.

Disadvantages

- Large impact on indigenous bird, aquatic and plant species and habitats.
- Major disruption to residents during site works.
- Expensive option.

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18. CONCLUSIONS

Much (but not all) of the western pond margin is potentially suitable for access with an excavator and trucks, to remove sediment and plant material.

Options such as hand removal of water lilies (and raupo) or the use of herbicides will leave the habitat (i.e. water depth) in a condition where re-invasion of water lilies (and raupo) is inevitable, and this may happen relatively quickly. On this basis, the preferred option would be to excavate all parts of the pond that can be reached with a long-reach excavator. Most of the existing raupo should be retained, but all water lilies that can be reached should be removed. Excavation should be undertaken to a depth of at least 3 m. There will still be a shallow margin where water lilies (and raupo) will be able to establish, but this will only comprise a limited area.

All other areas of water lily, which cannot be reached with an excavator, should be treated with a herbicide. Repeated treatments will be required, to ensure that all regrowth is killed. Excavation should be undertaken prior to herbicide treatment, to see what water lilies remain.

Vegetation and sediment should be stockpiled on the grassed area of the reserve to dewater and to allow any stranded eels to return to the pond.

Long-term maintenance should comprise hand removal of water lilies on a five-yearly basis, with dredging undertaken when required (five to ten year intervals).

A notified resource consent will be required to provide a variation to the Piha Reserves Management Plan to allow mechanical removal of vegetation and sediment removal. It appears the majority of the local community will support a plan to maintain open water in the pond.

Works should be undertaken between February and April when impacts on wildlife using the pond will be at a minimum, and pond level should be the lowest.

Ensure that works planned are approved and signed off by Department of Conservation prior to any works being undertaken.

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COST ESTIMATES FOR DREDGING OF SEDIMENT

Cost estimates have been based on dredging a range of selected areas for comparison only. It is assumed that a sediment layer averaging 1.5m will be dredged. Actual costs will depend on numerous variables including size of area to dredge, disposal location, access and work space on site.

Surface Area[1] (m^2)	Volume[2] (m^3)	Total Weight[3] (tonnes)	Excavator hours[4]	Excavator Cost[5]	Disposal Costs[6]	
					Cartage	Tip Fees
2,500 (c.92%)	3,750	5,625	180 (22.5 days)	$24,300	$103,500	$478,125
2,000 (c.74%)	3,000	4,500	144 (18 days)	$19,440	$82,800	$382,500
1,500 (c.55%)	2,250	3,375	108 (13.5 days)	$14,580	$62,100	$286,875
1,000 (c.37%)	1,500	2,250	72 (9 days)	$9,720	$41,400	$191,250
500 (c.18%)	750	1,125	36 (4.5 days)	$4,860	$20,700	$95,625

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1. Surface area of area to be dredged (percentage of total water lily infestation)
2. Assume that average depth of sediment removed is 1.5 metres deep.
3. Assume that weight of sediment is approximately 1.5 tonnes per cubic metre.
4. Assuming 250 tonnes per day can be dredged from pond (8 hour day).
5. Based on $135.00 per hour. Does not include excavator transport and setup costs.
6. Cost includes cartage ($18.40/tonne) and tipping fees at The Concourse ($85/tonne). Disposal at Piha will reduce this cost considerably

BIRD SPECIES RECORDED AT THE SITE

Anas platyrhynchos	mallard duck
Gerygone igata	grey warbler
Hemiphaga novaeseelandiae	kereru
Hirundo tahitica ssp. *neoxena*	welcome swallow
Porphyrio porphyrio ssp. *melanotus*	pukeko
Prosthemadera novaeseelandiae	tui
Rhipidura fuliginosa	fantail
Todiramphus sanctus	kingfisher
Turdus merula	blackbird
	Muscovy duck

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APPENDIX 3

FRESHWATER
DATABASE FORM

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FRESHWATER FISH DATABASE FORM

1

Date	8/07/2004	River/Lake system Pond			Catchment number 443
Time	1600	Sampling locality Claude Able Pond			
Observer	lak	Access			Altitude (m)
Organisation	lndm	NZMS 260 Map no. q11	Coord. 26413 64715		Distance inland (km)
Fishing method	ntc	Area fished (m2) or no. nets used 10	Number of electric fishing passes		Tidal water n

HABITAT DATA

Water	Colour t				Clarity m				Temp.		pH	
	Average width(m)		Average depth(m)		Maximum depth(m)				Conductivity			
Habitat type(%)	Still	100	Back-water	0	Pool	0	Run	0	Riffle	0	Rapid 0	Casc. 0
Substrate type(%)	Mud	10	Sand	90	Fine gravel	0	Coarse gravel	0	Cobble	0	Boulder 0	Bed-rock 0
Fish cover(%)	Substrate		Weed algae	100	Instream debris		Bank veg.		Undercut bank		Ohead shade	Other
Catchment vegetation(%)	Native forest	90	Exotic forest	0	Farm	0	Urban zone	10	Scrub	0	Swamp land 0	Other 0
Riparian vegetation(%)	Native forest	50	Exotic forest	0	Grass lusock	10	Exposed bed	0	Scrub willow	0	Raupo flax 40	Other 0
Type of river/stream/lake sldmsm												Photo no.
Water level n			Downstream barrier y						Pollution n			
Bottom fauna abundance m			Predominant species group o						Permanent water y			

FISH DATA

Species	Abundance	Length	Habitat/Comments
none			

Comments 2 x fyke nets, 8 baited gee minnow traps and nighttime spotlighting used.

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APPENDIX 4

FRESHWATER
FISH HABITAT ASSESSMENT
FORMS

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Habitat Assessment - Field Data Sheet

Date	8 JULY 2004
Stream Name	CLAUDE ABEL POND
Location	PIHA BEACH
Map reference	Q11 26413 64713
Investigators	WILDLAND CONSULTANTS

Weather Conditions	Current	Past 24 hrs
Storm (heavy rain)	☐	☐
rain (steady rain)	☐	☐
Showers (intermittent)	☐	☐
% cloud cover	☐	☐
clear / sunny	☑	☑

Photo taken No ☐ Yes ☑

Film No. ☐

Photo No. ☐

Has there been heavy rain in the past 2 days? Yes ☐ No ☑

Site location map

Predominant surrounding land use

Forest	☑	Commercial	☐
Field/pasture	☐	Industrial	☐
Agricultural	☐	Other	☐
Residential	☐		

Water Level

Dry	☐
Isolated pools	☐
Perennial	☑

Litter

Abundant	☐	Rare	☐
Common	☑	Absent	☐

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Habitat Assessment - Field Data Sheet

Macrophytes

	None	Rare	Sparse	Com.	Abun.
Rooted emergent					
Rooted submergent					

Channel shading (%) 10 %

Water odours

Normal/none	✓
Petroleum	
Fishy	
Sewage	
Chemical	
Other _____	

Periphyton

		None	Rare	Sparse	Com.	Abun.
Thin mat/film: *(<0.5 mm thick)*	green					
	light brown					
	black/dark brown					
Medium mat: *(0.5-3 mm thick)*	green					
	light brown					
	black/dark brown					
Thick mat: *(>3 mm thick)*	green/light brown					
	black/dark brown					
Filaments, short *(<2cm long)*	green					
	brown reddish					
Filaments, long *(>2cm long)*	green					
	brown reddish					

Water quality

Temperature _____ pH _____

Specific conductance _____ Turbidity _____

Dissolved oxygen _____ WQ instrument used _____

Water surface oils

None	✓
Slick	
Sheen	
Globs	
Flecks	
Other _____	

Turbidity (if not measured)

Clear	
Slightly turbid	
Turbid	
Opaque	
Stained	✓
Other _____	

Sediment / Substrate odour

Normal/none	✓
Petroleum	
Anaerobic	
Sewage	
Chemical	
Other _____	

Sediment / Substrate deposits

None	✓
Sludge	
Fiber	
Sand	
Shells	
Other _____	

Macroinvertebrate Sampling - Additional Habitat Details

Proportion of study reach (%)

Pool	
Riffle	
Run	
Chute	
Waterfall	

Substrates sampled (%)

Woody debris	
Slow bank	
Fast bank	
Riffle	
Macrophyte	
Other	

Riffle type (%)

Bedrock	
Boulder	
Cobble	
Gravel	

Packing of cobble *(determined by kicking substrate)*

Tightly packed ☐ Moderately packed ☐ Loose ☐

Cobble Periphyton

Diatom slime ☐ Bryophytes ☐ Light algae ☐ Heavy algae ☐ None ☐

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Habitat Assessment
Field Data Sheet

Stream CLAUDE ABEL POND

Date 8 JULY 2004

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1 Aquatic Habitat Abundance	> 50% of channel favorable for epifaunal colonisation and fish cover. Cover may include woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	30-50% of channel contains stable habitat.	10-30% of channel contains stable habitat.	< 10% of channel contains stable habitat.
	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2 Aquatic Habitat Diversity	Wide variety of stable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris absent or may be smothered by sediment.	Stable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several). POND
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 (4) 3 2 1 0
3 Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present. Deep > 0.5 m Shallow 0.2-0.5 m	Limited variety of hydrologic conditions; deep pools absent.	Uniform hydrologic conditions; uniform depth and velocity; pools absent.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 (1) 0
4 Channel Alteration	Natural channel and meander pattern; no evidence of channelisation, dredging, stabilisation, or other human alteration.	Minimal channel alteration; < 10% channelised or culverted; past channelisation healed over with vegetation.	Moderate channel alteration; 10-50% channelised or culverted with man-made materials (gabions, rip-rap, concrete, pilings)	Extensive channel alteration; > 50% channelised or culverted.
	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0
5 Bank Stability	Stable < 5% bank affected; evidence of erosion or bank failure absent or minimal potential for future problems.	Moderately stable 5-30% affected; areas of erosion mostly healed over; some potential for future problems.	Moderately unstable 30-60% affected; high erosion potential during floods.	Unstable 60-100% affected; eroded areas along runs and bends, bank sloughing and erosion scars common.
Left bank	10 (9)	8 7 6	5 4 3	2 1 0
Right bank	10 (9)	8 7 6	5 4 3	2 1 0

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6 Riparian Vegetation Type (within 10 meters)	Predominant type is: Native forest (NF) or Native shrubland (NS)	Predominant type is: Mixed shrubland (MX)	Predominant type is: Native treeland (NT), Exotic treeland (CET, OET), or Exotic plantation (EP)	Predominant type is: Grassland (GR), Suburban/urban (SU), Unvegetated (UN)
Left bank	10 (9)	8 7 6	5 4 3	2 1 0
Right bank	10 (9)	8 7 6	5 4 3	2 1 0
7 Riparian Zone Width (within 20 meters)	Width of undisturbed zone > 15 meters; no signs of human activity in last 30 years	Width of undisturbed zone 10-15 meters; human activity minimal	Width of undisturbed zone 5-10 meters; substantial human activity	Width of undisturbed zone < 5 meters; little or no undisturbed vegetation
Left bank	10 9	8 (7) 6	5 4 3	2 1 0
Right bank	10 9	8 7 6	5 (4) 3	2 1 0

Total Score 79

maximum score = 140 (perennial, parameters 1-7)
maximum score = 80 (ephemeral, parameters 4-7)

Comments:

- fish habitat
- barriers to fish passage
- evidence of stable pools
- catchment erosion
- flow (low, medium, high)
- seaps or springs
- waterfalls
- discharges or outfalls
- evidence of grazing stock access
- unique features
- crossings / tracks

CLAUDE ABEL POND HAS NO SURFACE INFLOWS/OUTFLOWS.

ONLY RELEVANT FIELDS HAVE BEEN COMPLETED.

FISHERIES DATA SUBMITTED TO NIWA FRESHWATER FISH DATABASE.

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Stream Habitat Assessment

Score sheet

Stream flow ↑

Stream _____

Date _____

Legend	Riparian zone (L)			Bank (L)		Aquatic Substrate			Bank (R)		Riparian zone (R)		
	10-20m	3-10m	0-3m			Inorganic					0-3m	3-10m	10-20m
	Width -			Stability		Organic			Stability		Width -		
				Inorganic material	Organic material	Width (m)	Max depth	Flow type	Inorganic material	Organic material			
0	Width -										Width -		
1													
2	Width -										Width -		
3													
4	Width -										Width -		
5													
6	Width -										Width -		
7													
8	Width -										Width -		
9													
10	Width -										Width -		

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