IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	an application by Watercare Services Limited to the Auckland Council to undertake works related to its proposed Huia Replacement Water Treatment Plant.

RESOURCE MANAGEMENT ACT 1991

EXPERT CONFERENCE – KAURI DIEBACK MANAGEMENT

JOINT WITNESS STATEMENT

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5. This is a signed Joint Witness Statement (JWS) by the three of the five expert kauri dieback ecologists who participated in the 13 March 2020 conference, and records the questions addressed during caucusing, and matters in agreement and

disagreement (with reasons), in the following Table:

ISSUE	**AGREEMENT/ DISAGREEMENT/ EXPLANATION/ COMMENTS**
Has the Biosense investigation met the brief?	Yes **[ALL AGREE]**
Has the risk profile of the project with respect to the spread of kauri dieback increased or decreased on the basis of testing results?	No change **[ALL except DH]** Increased Risk. DH. The survey shows more Kauri with signs of PA infection /ill health and Phytophthora detections than I expected from the earlier surveys. Was gratified to see some areas of native vegetation have a low frequency of infection detection. While some aspects of the pattern of distribution are not as expected (e.g., tracks within the Project Site do not appear to be a key focus of infection, though the Exhibition Drive track had frequent detections), testing has generally borne out prior assumptions on which the proposed management strategy was based, ie that Pa is present to a greater or lesser extent throughout the site. **[SF]** The survey shows that the distribution of phytophthora within the survey area is very patchy with some areas within the project footprint showing very low frequency of infected samples while other areas show high frequency of infection including areas adjacent to current Watercare buildings. Highlights importance of isolating/ protecting the lower catchment. **[DH]** While the risk relating to *Phytophthora agathidicida* presence is as expected, the report has also confirmed the suspicion that another species, *P. cinnamomi* is also present. This can also harm kauri, and highlights the precarious state of the kauri health in the site and exacerbates the over-all threat to kauri posed by the works **[MF]** *P. cinnamomi* is also a known pathogen of other native species. **[DH]**
Is the proposed development likely to worsen the spread of KD relative to the status quo, assuming the KDMP is properly implemented?	**SF = Risk no greater than status quo:** Testing has demonstrated that in the absence of significant soil disturbance, Pa has dispersed from infected trees to locations within the site and adjacent Clarks Bush reserve. Sampling within the watercourses detected Pa frequently in stream channels that drain into the catchments below the site. In the context of this existing distribution and evidence of movement, and with the controls proposed in the KDMP which will much more tightly control and focus discharges of surface runoff, and manage vehicle movements entering and leaving the site, I do not consider that the proposal will increase the distribution of Pa within the catchment, or the extent of kauri infection within the catchment. I agree that concentrations of Pa within water discharged from the site directly to the streams are likely to increase (depending on the

	timing and intensity of rainfall during works), but I do not consider this will further spread the disease within the catchment, given that the water will stay in the watercourse, and these streams already carry the infection. **MF, NW, DH = Risk is greater:** The proposed activity contravenes every principle of KD management. These principles are: Don't move the causal organism *P. agathidicida;* don't disturb soil around kauri; avoid creating wet conditions around kauri and working in wet conditions; avoid stressing or injuring kauri especially their roots, avoid movement of material from areas where Pa is present. The development will massively disturb a site with Pa infection, exposing the propagules contained in soil, roots and kauri tissue to vectors that don't currently reach them. Currently, potential vectors such as rainfall interact with closed, vegetated surfaces, and flows via natural flowpaths to waterways. With the development, rainfall and other vectors will interact with more risky substrate, and move off site with Pa in it. Vehicle and personnel movements off site and across site are also a significant source of risk, as despite best efforts, cleaning vehicles and personnel can't guarantee total containment. Pulses of water and sediment with much higher concentrations of Pa will enter the watercourse, greatly increasing the likelihood of spread from streams into the surrounding catchment. In addition, the PA in the site will find its host population altered from a healthy, relatively resistant one to a stressed, root-pruned and exposed one, therefore able to move through and infect it to a greater extent / severity, which in turn increases the propagule source represented by the disturbed site. Development removes vegetation which can potentially act as buffer to reduce PA activity and restrict PA movement. **[DH]**
Is the proposed KDMP approach an 'avoidance' or 'mitigation' strategy?	The proposed approach is mitigation, not avoidance **[SF CM MF CT DW DH].**
Does the management plan address the risk to a level that is as low as reasonably practicable (ALARP)	Yes **[SF CM DW DH CT]** I agree that the plan aims to address the risk to a level that is ALARP at a high-level, but the technical detail is not currently developed/shown to the final standard that will be required **[MF].** There is no feasible management technique that is guaranteed to totally avoid moving the pathogen off the site **[SF CM DW DH]** Agree total containment is challenging but it should nevertheless be the goal – The applicant's experts haven't justified/ given technical basis for why total

	containment of water & sediment during earthworks isn't feasible **[MF].** Even if complete containment can't be achieved, there are opportunities to mitigate spread of PA/ sediment by selection of stabilisation methods **[CT].** Irrespective of what happens, the wider site will need a KDMP which takes into account the PA survey results. **[DH SF]** Amend KDMP Section 6.5 (bullet point 1) to remove comment that lining trucks "may not be practical" in some situations **[MF CT SF CM].** May be some further opportunities to optimise detention pond sizing **[CT CM DH MF]**
Is there sufficient management of water/ sediment going into the watercourse?	No - increased disturbance factors & movement/ mobilisation of soil will greatly elevate inoculum into the catchment **[NW, MF]** Same volume of water leaves the site; collected and conveyed to the stream vs surface runoff (sheet flow); sediment discharge is minimal. Pond currently sized to fully contain 10 yr rainfall event (no decanting) from 3000m² earthworks area and was proposed as a provision to allow some form of treatment to be applied should something be available prior to siteworks commencing. Following treatment water would be discharged to stream in a controlled manner. **[CM]** While disposal by sucker trucks or sewer are feasible these options are not without risk. e.g. Condition of the sewer network (seepage/infiltration) and leakage from sucker trucks for larger water volumes **[CM]** A greater volume of water will leave the site via surface flows after vegetation clearance. Under current forested conditions some evaporation occurs before rainfall reaches the forest floor, and some of that that does reach the forest floor will be re-absorbed by plants. Also, in addition to rainfall, water will be brought in for washdown facilities and other site works that might require it e.g. dust suppression **[MF, CT].** KDMP needs to include contingency measures for detecting and responding to large events/ other risk scenarios. Need triggers for stabilising the site if a large rainfall event is forecast. **[CT, DH, MF]**
Is it correct that the KDMP primarily applies to earthworks? Is this appropriate?	Off-site movement of sediment and water is the main vector for movement of Pa, and bulk earthworks is the activity where this mostly occurs , so much of the detail of the KDMP addresses managing movement of water and sediment off the site during earthworks. However, hygiene practices will be important throughout the life of the Project and are provided for in the KDMP **[SF CM]**

	Infection sources will remain within the Project Site, adjacent to the WTP, while much buffering vegetation is removed. These areas will need ongoing management which should be specified in the KDMP. **[DH, MF]**
Is the staging approach appropriate and practical?	Yes **[DW CM SF]**
Is soil leaving the site adequately contained under proposed KDMP specifications?	Topsoil disposal to an approved facility is appropriate. **[SF CM CT DH]** Topsoil disposal to an approved facility is the most appropriate means of disposal <u>if it has already been excavated and cannot remain on site. Note that such movement may require exemption to move an unwanted organism under S52 of the Biosecurity Act and Auckland Regional Pest Management Plan 2020-2030 rules **[MF].**</u> Principles/ specifications for subsoil disposal are not clear enough, given that there remains a residual risk that this material will contain Pa due to recontamination during earthworks, and/ or movement through moist soil **[MF DH]** Disposal specifications for material from KCZs need clarification in regards to the depth of soil that is proposed to be removed – 0.5 + 0.5 m is inadequate in areas where kauri roots are present because roots extend below this depth. Excavation would instead need to include the entire depth of the roots plus a buffer **[MF]** On balance, a local site for disposal of all soil material would be preferable to transporting material long distances through disease-free environments. **[MF SF CM CT DH],**(subject to (a) kauri dieback management protocols are followed (b) the site contains and storage kills PA and other phytophthora propagules, as well not exposing local botanical values to increased risk. **[DH]** KDMP should include principles for selection and management of 'receptor sites' **[MF SF CM CT DH]** Need flexibility in KDMP to ensure identification and appropriate containment of material around kauri roots/ porous material which may extend beyond 0.5m of soil plus 0.5 m of soil, depth needs to be determined by risk of PA contamination, ie by the porosity and kauri root content of the soil and subsoil media **DH MF SF]** Note that the KDMP (Section 6.1, para 1) specifies removal of topsoil to a nominal depth of 0.5m plus a further 0.5 m of subsoil, though the Project Arborist supervising the works on-site is to specify the actual required depth [not less than 1 m, i.e. not reduce the depth below the nominal criteria – MF]. Oversight by a geotechnical expert may also be appropriate to evaluate relevant factors such as soil porosity/ **[SF]**

	There is very limited evidence available to appraise the assumption that subsoil is not likely to be infected **[ALL AGREE];** some evidence it could be **[DH, MF]**
Is some form of ongoing surveillance for Pa appropriate? What to test?	Yes. Need a means to assess whether management methods are working, and adapt accordingly **[ALL AGREED]** Yes you need means to assess whether containment management methods are working – primarily this assessment should concern whether soil and/or water are escaping the site. Testing for PA is additional. **[MF]** Pathogen testing of geotechnical cores present an opportunity to audit/ test the assumption that infection is generally confined to the topsoil layer. **[ALL AGREE]** The KDMP should specify “trial” stages to be undertaken early in the topsoil removal phase of work, during which a Pa sampling regime (to be developed with the advice of Biosense or appropriately qualified pathologists) is implemented to enable auditing of all specified hygiene and containment measures to ensure their effectiveness. Testing of subsoil following topsoil stripping would be part of this regime. **[ALL AGREE]** The KDMP should specify the contingency actions that will be taken if hygiene and containment measures are found to be not working, or if subsoil is found to be contaminated **[ALL AGREE]** Stages with higher rates of positive Pa detections should be the focus of audit investigations (e.g., WTP Stages 2/3/9 in Yorke Catchment; WTP Stages 13/14 in Armstrong Catchment). Dimensions and sequencing of stages can be modified to encompass Pa ‘hotspots’. **[SF]**

Ecological Expert Witness’ Signature Page

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David Havell D C Havell Dated 29/01/2021

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Does the management plan address the risk to a level that is as low as reasonably practicable (ALARP)	Yes **[SF CM DW DH CT]** I agree that the plan aims to address the risk to a level that is ALARP at a high-level, but the technical detail is not currently developed/shown to the final standard that will be required **[MF].** There is no feasible management technique that is guaranteed to totally avoid moving the pathogen off the site **[SF CM DW DH]** Agree total containment is challenging but it should nevertheless be the goal – The applicant's experts haven't justified/ given technical basis for why total

	containment of water & sediment during earthworks isn't feasible **[MF].** Even if complete containment can't be achieved, there are opportunities to mitigate spread of PA/ sediment by selection of stabilisation methods **[CT].** Irrespective of what happens, the wider site will need a KDMP which takes into account the PA survey results. **[DH SF]** Amend KDMP Section 6.5 (bullet point 1) to remove comment that lining trucks "may not be practical" in some situations **[MF CT SF CM].** May be some further opportunities to optimise detention pond sizing **[CT CM DH MF]**
Is there sufficient management of water/ sediment going into the watercourse?	No - increased disturbance factors & movement/ mobilisation of soil will greatly elevate inoculum into the catchment **[NW, MF]** Same volume of water leaves the site; collected and conveyed to the stream vs surface runoff (sheet flow); sediment discharge is minimal. Pond currently sized to fully contain 10 yr rainfall event (no decanting) from 3000m² earthworks area and was proposed as a provision to allow some form of treatment to be applied should something be available prior to siteworks commencing. Following treatment water would be discharged to stream in a controlled manner. **[CM]** While disposal by sucker trucks or sewer are feasible these options are not without risk. e.g. Condition of the sewer network (seepage/infiltration) and leakage from sucker trucks for larger water volumes **[CM]** A greater volume of water will leave the site via surface flows after vegetation clearance. Under current forested conditions some evaporation occurs before rainfall reaches the forest floor, and some of that that does reach the forest floor will be re-absorbed by plants. Also, in addition to rainfall, water will be brought in for washdown facilities and other site works that might require it e.g. dust suppression **[MF, CT].** KDMP needs to include contingency measures for detecting and responding to large events/ other risk scenarios. Need triggers for stabilising the site if a large rainfall event is forecast. **[CT, DH, MF]**
Is it correct that the KDMP primarily applies to earthworks? Is this appropriate?	Off-site movement of sediment and water is the main vector for movement of Pa, and bulk earthworks is the activity where this mostly occurs , so much of the detail of the KDMP addresses managing movement of water and sediment off the site during earthworks. However, hygiene practices will be important throughout the life of the Project and are provided for in the KDMP **[SF CM]**

	Infection sources will remain within the Project Site, adjacent to the WTP, while much buffering vegetation is removed. These areas will need ongoing management which should be specified in the KDMP. **[DH, MF]**
Is the staging approach appropriate and practical?	Yes **[DW CM SF]**
Is soil leaving the site adequately contained under proposed KDMP specifications?	Topsoil disposal to an approved facility is appropriate. **[SF CM CT DH]** Topsoil disposal to an approved facility is the most appropriate means of disposal <u>if it has already been excavated and cannot remain on site. Note that such movement may require exemption to move an unwanted organism under S52 of the Biosecurity Act and Auckland Regional Pest Management Plan 2020-2030 rules **[MF].**</u> Principles/ specifications for subsoil disposal are not clear enough, given that there remains a residual risk that this material will contain Pa due to recontamination during earthworks, and/ or movement through moist soil **[MF DH]** Disposal specifications for material from KCZs need clarification in regards to the depth of soil that is proposed to be removed – 0.5 + 0.5 m is inadequate in areas where kauri roots are present because roots extend below this depth. Excavation would instead need to include the entire depth of the roots plus a buffer **[MF]** On balance, a local site for disposal of all soil material would be preferable to transporting material long distances through disease-free environments. **[MF SF CM CT DH],**(subject to (a) kauri dieback management protocols are followed (b) the site contains and storage kills PA and other phytophthora propagules, as well not exposing local botanical values to increased risk. **[DH]** KDMP should include principles for selection and management of 'receptor sites' **[MF SF CM CT DH]** Need flexibility in KDMP to ensure identification and appropriate containment of material around kauri roots/ porous material which may extend beyond 0.5m of soil plus 0.5 m of soil, depth needs to be determined by risk of PA contamination, ie by the porosity and kauri root content of the soil and subsoil media **DH MF SF]** Note that the KDMP (Section 6.1, para 1) specifies removal of topsoil to a nominal depth of 0.5m plus a further 0.5 m of subsoil, though the Project Arborist supervising the works on-site is to specify the actual required depth [not less than 1 m, i.e. not reduce the depth below the nominal criteria – MF]. Oversight by a geotechnical expert may also be appropriate to evaluate relevant factors such as soil porosity/ **[SF]**

	There is very limited evidence available to appraise the assumption that subsoil is not likely to be infected **[ALL AGREE];** some evidence it could be **[DH, MF]**
Is some form of ongoing surveillance for Pa appropriate? What to test?	Yes. Need a means to assess whether management methods are working, and adapt accordingly **[ALL AGREED]** Yes you need means to assess whether containment management methods are working – primarily this assessment should concern whether soil and/or water are escaping the site. Testing for PA is additional. **[MF]** Pathogen testing of geotechnical cores present an opportunity to audit/ test the assumption that infection is generally confined to the topsoil layer. **[ALL AGREE]** The KDMP should specify “trial” stages to be undertaken early in the topsoil removal phase of work, during which a Pa sampling regime (to be developed with the advice of Biosense or appropriately qualified pathologists) is implemented to enable auditing of all specified hygiene and containment measures to ensure their effectiveness. Testing of subsoil following topsoil stripping would be part of this regime. **[ALL AGREE]** The KDMP should specify the contingency actions that will be taken if hygiene and containment measures are found to be not working, or if subsoil is found to be contaminated **[ALL AGREE]** Stages with higher rates of positive Pa detections should be the focus of audit investigations (e.g., WTP Stages 2/3/9 in Yorke Catchment; WTP Stages 13/14 in Armstrong Catchment). Dimensions and sequencing of stages can be modified to encompass Pa ‘hotspots’. **[SF]**

Ecological Expert Witness’ Signature Page

Dr Sarah Flynn Dated 29/01/21

Dr Murray Fea Dated

Dr David Havell Dated

Dr Nick Waipara declined to sign and has withdrawn from proceedings.

BioSense
ENVIRONMENTAL RESEARCH

Kauri dieback disease surveillance of Watercare's proposed replacement water treatment plant site at Waima Catchment

By BioSense Limited

For Watercare

Date November 2020

Preface

This report has been prepared by BioSense Limited for Watercare. No liability or responsibility is accepted by BioSense Limited or its employees for any use of or reliance upon this report by any third party.

Confidential – for Watercare use only.

For all enquiries contact
lee@biosense.co.nz

Contents

Executive summary

BioSense was requested by Watercare to develop and implement a field-testing protocol to assess the presence and distribution of *Phytophthora agathidicida,* the kauri dieback causing pathogen, within the proposed construction footprint, the wider Project Site, and within a surrounding buffer area.

The objective of this work was to develop and implement sampling protocol to test for:

1. The disease status of kauri trees within and surrounding the proposed works footprint.
2. The presence and distribution of phytophthora in soil within the Project Site and a surrounding buffer.
3. The presence and distribution of phytophthora in soil within the Project Site and a surrounding buffer.

A sampling protocol was directed to address the following prescription:

- The buffer is to be of sufficient extent to encompass interconnected root systems of vegetation within and surrounding the Project Site, so the risk that these networks may as a pathway move phytophthora into or out of the site can be assessed.
- Watercourses are identified as a key potential vector for the spread of kauri dieback disease.
- Sampling will include all sites of human and feral animal disturbance.
- Sample collection and analysis methods will seek to maximise detection probability within practical limits, i.e., the scale and pattern of sampling is to give the best chance that kauri dieback-causing pathogens would be detected if present within the construction footprint and wider Project Site.

A field survey confirmed the presence of kauri dieback symptoms within the Project Site, and surrounding buffer within Clarks Bush.

Analysis of soil samples detected the presence of *Phytophthora agathidicida* and *Phytophthora cinnamomi* in soil taken from the Project Site, and adjoining buffer area within Clarks Bush.

Analysis of water samples detected the presence of *Phytophthora agathidicida* and *Phytophthora cinnamomi* in water taken from the Waituna stream tributary network within the Project Site, and adjoining buffer area within Clarks Bush.

1. Who we are

At BioSense we seek to understand more about our environment to protect it for the future. To do this, we provide surveillance, management, treatment, and eradication options to combat invasive pests and pathogens and we are committed to doing this in a collaborative, co-created manner. We believe that collaboration is essential for successful and durable outcomes and we work with Iwi, community-groups, Universities, Crown Research Institutes, and other experts to develop the best qualified team, for the protection of our environment and the well-being of Aotearoa. We are also guided by research and use this to constantly improve and develop best practice.

An area of focus for the BioSense team members to date has been the management of kauri dieback and many of the team have been involved in leading the research to mitigate the impact and management of kauri dieback since 2010. We have also developed best practice in surveillance and have designed, conducted, analysed, and reported on all kauri dieback surveillance on land across Auckland between 2010 and 2018, and Waipoua forest since 2010. This work includes investigating more than 2,000 sites of potential kauri dieback, conducting health assessments on more than 75,000 kauri, and collecting more than 4,500 diagnostic samples for analysis across Northland, Auckland, Waikato, and Bay of Plenty.

We have also been involved in research into potential treatment tools for kauri dieback since 2010, most notably the research and development of the phosphite tool. BioSense designed and conducted the first large-scale application of phosphite as a treatment for kauri dieback with more than 15,000 kauri treated and assessed to enable long-term impact monitoring by 2020, with treatment of a further 2,000 planned for 2021. Members of BioSense are also involved in designing and managing a community-based social science project aimed at engaging the community to care for kauri and manage kauri dieback, with a range of potential tools being assessed.

A selected bibliography of kauri dieback research outputs is listed in appendix 1 and a list of kauri dieback surveillance project implemented by this team are listed in appendix 2.

2. Background

Watercare operates water supply dams within the Waitākere Ranges, including the Upper and Lower Huia Dams and the Upper and Lower Nihotupu Dams. The Huia Water Treatment Plant (WTP) located in Waima (named for the source of the water) treats the water from these dams before it is distributed via the water transmission network.

Watercare seeks to construct a new WTP to replace the which is nearing the end of its operational life. As part of this project Watercare is also proposing to construct two treated water reservoirs on the Project Site to increase treated water storage capacity.

Watercare proposes to construct the replacement WTP at a site on the corner of Manuka Road and Woodlands Park Road, directly across from the existing Huia WTP site. A new 25ML treated water reservoir will be located on the northern side of Woodlands Park Road (Reservoir 1), with another 25ML reservoir (Reservoir 2) subsequently constructed on the existing Huia WTP site once the existing plant has been decommissioned.

While the Project Site is within Watercare land designated for water supply purposes (water treatment plants and associated structures) in the Auckland Unitary Plan, it is also identified as part of an extensive Significant Ecological Area (SEA_T_5539) that essentially encompasses the entire Waitakere Ranges. Native forest and scrub cover 3.5 ha of the total 4.3 ha construction footprint.

The construction footprint encompasses secondary vegetation communities (kanuka and mahoe-dominated) of varying age and condition. Old-growth kauri and podocarp forest remnants are present immediately adjacent to the site.

The Project Site is in the headwaters of two Waituna Stream tributaries, including Armstrong Stream to the west and Yorke Stream to the east. Little Muddy Creek estuary is the receiving environment for the site.

The Project Site adjoins Clarks Bush, a public reserve containing several very large kauri trees, and for many years the Watercare land was essentially managed as part of the reserve. A walking track through the reserve intersects the proposed construction footprint for the WTP.

Kauri forest interspersed with residential development dominates the broad ridgelines immediately southward of the Project Site. Kauri dieback (causal agent *Phytophthora agathidicida*, PA) is a chronic, currently incurable disease affecting kauri trees of all ages (Waipara et al., 2013), and possibly also affecting other native plant species. Kauri dieback disease is caused by a soil and water borne primary pathogen of New Zealand kauri (*Agathis australis*). The above-ground symptoms of kauri dieback infection include yellowing of the leaves, thinning of the canopy and lesions on the lower stem which often encircle the base and produce copious amounts of resin (kauri gum).

The disease is known to be present throughout some, but not all, kauri areas within the Auckland region and surveys suggest that the extent of symptomatic trees in the region has substantially increased in recent years. However, with the "disease" expression lagging behind fine-root infection, not all healthy-looking forest can be assumed to be free of PA, due to the latent-phase of the disease process.

Kauri dieback has a wide distribution, both on a local and regional scale and is found on private, and public land. In Auckland it is most prevalent in the Waitākere Ranges Regional Park, with nearly 19% of the dense kauri forest within the regional park found to be infected with kauri dieback, and nearly 5% possibly infected. There is also kauri dieback present on local parks and private land throughout West Auckland, private land on the Awhitu Peninsula, and in North Auckland, local parks on the North Shore, and on public land in Albany, Okura, Pakiri, and Aotea and Hauturu.

However, some substantial tracts of kauri ecosystems remain non-symptomatic and spread prevention and containment are top management priorities.

A total of six phytophthora species are known to occur in the kauri forest: *P. agathidicida*, *P. chlamydospora*, *P. cinnamomi*, *P. kernoviae*, *P. multivora*, and *P. nicotianae* (Scott and Williams, 2014). All are considered exotic except for *P. kernovieae* (Studholme et al. 2016).

3. The problem

The proposed works footprint for both the replacement WTP and Reservoir 1 extend into an area of mature kauri trees, and stands of kauri are present nearby, both within the Project Site and in adjacent residential and reserve land to the south. No mature kauri had been reported within the works footprint itself. Kauri seedlings and saplings had been found within the WTP footprint, in the vicinity of large trees near the southern boundary. Systematic assessment of kauri presence in the forest directly adjacent to the project site had not been conducted but saplings had been observed and mature kauri have been mapped within the forest.

Symptoms consistent with kauri dieback (collar rot and gummosis) had been observed on a single large kauri tree within a mature kauri forest stand on the northern side of Woodlands Park Road (north-western corner of the Project Site). Auckland Council recorded a tree with kauri dieback symptoms in a similar location in 2009, and this may be the same tree. Auckland Council has recently identified a symptomatic tree near the northern Project Site boundary (on the escarpment above Exhibition Drive Walk) via aerial surveillance, and a typical "gummy" lower-trunk lesion was noted on a tree adjacent to the existing WTP in December 2019.

No laboratory testing had previously been undertaken within the project site to ascertain the presence of *Phytophthora agathidicida* or other phytophthora implicated in kauri decline, but the BioSense team has worked extensively in the Waitakere Ranges and Titirangi area (Bellgard et al. 2014; Hill et al. 2016) and shown that *P.agathidicida*, *P. cinnamomi*, *P. multivora*, *P. kernoviae*, and *P. chlamydospora* are all present in the surrounding area (Bellgard et al. 2013).

Spread of kauri dieback from the site into the surrounding catchment and beyond has been identified as a potentially risk of the proposed WTP development, due to the extent and volume of earthworks required, and the substantial quantity of soil to be transported and disposed of offsite.

4. Overview of the solution

BioSense was requested to develop and implement a field-testing protocol to assess the presence and distribution of *Phytophthora agathidicida,* the kauri dieback causing pathogen within the proposed construction footprint, the wider Project Site, and within a surrounding buffer area.

The objective of this work was to develop and implement sampling protocol to test for:

1 The disease status of kauri trees within and surrounding the proposed works footprint.
2 The presence and distribution of phytophthora in soil within the Project Site and a surrounding buffer.
3 The presence and distribution of phytophthora in soil within the Project Site and a surrounding buffer.

A sampling protocol was directed to address the following prescription:

- The buffer is to be of sufficient extent to encompass interconnected root systems of vegetation within and surrounding the Project Site, so the risk that these networks may as a pathway move phytophthora into or out of the site can be assessed.
- Watercourses are identified as a key potential vector for the spread of kauri dieback disease.
- Sampling will include all sites of human and feral animal disturbance.
- Sample collection and analysis methods will seek to maximise detection probability within practical limits, i.e., the scale and pattern of sampling is to give the best chance that kauri dieback-causing pathogens would be detected if present within the construction footprint and wider Project Site.

Sampling was also requested to test for *Phytophthora cinnamomi* presence due its known co-occurrence and impact upon kauri (Podger and Newhook 1971). *Phytophthora multivora* was suggested as a pathogen to test for but a LAMP-based diagnostic does not exist for this species of *Phytophthora*.

The methodology was developed and submitted to Watercare. It was peer reviewed by Dr Nick Waipara and Jack Craw (on behalf of Titirangi Residents Association), David Havell (Department of Conservation), and Dr Murray Fea (Auckland Council) before being agreed to by Watercare and implemented by BioSense.

BioSense recognises the importance of mana whenua as kaitiaki of the ngahere. It was highlighted that the surveillance was being conducted within the rohe of Te Kawerau ā Maki and acknowledged that Te Kawerau ā Maki had been informed of the surveillance project during consultation on the HTP development and were supportive of the surveillance being conducted.

5. Approach and methodology

A core concept to this investigation was to examine the presence/absence and distribution of kauri pathogens within and surrounding the Project Site and to provide levels of confidence in the data delivered.

The national Kauri Dieback Programme has not yet bench-marked the effectiveness or efficiency of the conventional soil bioassay protocol developed in 2010. Consequently, we do not yet have an estimate of the frequency of isolation of *P. agathidicida* which can be used to carry out a power analysis and/or deliver confidence of freedom of disease for this study. Therefore, The investigation could not produce statistical significance of the results generated to provide confidence via power analysis. The design has been based solely on current knowledge and expert opinion.

The surveillance and sampling design took a multi-layered approach based on identified risk factors. The approach utilised the concept of layering of risk factors to create higher levels of sampling within higher risk areas. The risk factors/layers of sampling targeted were:

- Grid based survey of risk – survey of the entire site in a 25 m x 25 m grid pattern to identify Kauri dieback related risk factors. No samples taken but data generated to inform future sampling
- Stratified sampling - uniform sampling on a 25 m x 25 m grid pattern across the entire site
- Kauri rootzone sampling – kauri health survey and soil sample from all kauri across the site
- Watercourse sampling – a sample at points where a watercourse intersects a project site boundary, construction boundary and buffer zone boundary and 25 m (linear) spacings along the watercourse.
- Track sampling – a sample at points where a track intersects a project site boundary, construction boundary and buffer zone boundary and 25 m (linear) spacings along the track
- Animal disturbance sampling – a sample at the point of disturbance. If the disturbance was longer than 25 m then samples were also taken every 25 m along the disturbance.

A site visit informed development of the buffer zone surrounding the project site and took into consideration, slope, vegetation, and physical factors such as the soil type. This was compared with the activity which has and will be occurring on site and the known biology and movement of the phytophthoras being investigated. A buffer zone of 100 m around the project site boundary was applied and this was then clipped to remove private property and hard surfaces, effectively limiting the buffer zone area to south eastern section of the site, extending into Clarks Bush Reserve. This is to address the brief of investigating the presence of phytophthora in the adjacent reserve but rather than investigating the whole reserve the design focused on intensive sampling in the risk area associated with the proposed Watercare works. Inclusion of private properties was considered when designing the buffer however it was determined that extending sampling in to private properties could be logistically difficult and would also be sampling where the risks of an potential future phytophthora introduction is beyond the control of Watercare with no way of identifying if any new introductions to those areas were due to the construction work or simply by the private landowners.

5.1 Grid based search to identify risk

Data supplied by Watercare gave indication of risk factors and allowed preliminary planning and display of the option. However, systematic surveillance of kauri through the buffer area and in-depth identification of animal disturbance across the entire site had not been conducted. A systematic grid-based search of kauri, watercourses and human and animal disturbance was conducted to add to data already supplied. This was used to identify points of additional sampling at any new locations of risk which are identified.

5.2 Stratified sampling

Phytophthora cinnamomi is known to be associated with non-kauri vegetation and knowledge about prevalence of *Phytophthora agathidicida* in non-kauri areas is unknown but expected. Bellgard et al. (2014) found PA in 19% of asymptomatic trees, compared with 60% of symptomatic trees. Nonetheless, all those samples were taken within a stand with many unhealthy kauri in proximity (< 50 m linear distance) to asymptomatic tree samples; hence these results cannot be extrapolated to stands of entirely healthy trees. Knowing how widespread *P. agathidicida* is in asymptomatic forests would have potentially profound impacts on the management strategies. For example, if *P. agathidicida* is widespread in a non-symptomatic state, then management of spread would be a lower priority and suggest a greater focus on precipitating causes of forest dieback (Black and Dickie 2016).

Testing of host-range of *P. agathidicida* is currently underway however recent research has confirmed that non-kauri areas adjacent to kauri forest, such as *Pinus radiata* forest and grass pasture can also harbour and host the kauri dieback pathogen (Lewis et al. 2019). Therefore, systematic sampling of kauri and non-kauri areas is essential to determine *Phytophthora* presence and distribution across the area.

A grid-based sampling regime of the entire site was implemented. Sampling occurred on a 25 m by 25 m grid pattern across the construction site, project site and buffer area with 250 g of soil/root being taken from each point across the grid. The design excluded areas of hard surface such as concrete drives and buildings.

A map of the stratified sampling locations is shown in appendix 3.

5.3 Kauri rootzone sampling

All kauri within the construction footprint, project site and buffer area were physically tagged, GPS location recorded and assessed for kauri dieback symptoms. The sampling followed the national 'Kauri Dieback Soil Sampling Guide' guidelines with the exception that all kauri were sampled rather than three trees per stand.

Eight points around a tree were sampled: four inner points and four beneath the outer edge of the canopy, which are then bulked into one single soil sample with a minimum mass of 250 g, relating to that kauri rootzone.

A map of the kauri rootzone sampling locations is shown in appendix 4.

5.4 Watercourse sampling

Phytophthora agathidicida is a soil-borne water mould and we know its movement is linked to soil physiological and hydrological factors. While intense investigation of the risk associated with watercourses and *Phytophthora agathidicida* has not been conducted, watercourses have been confirmed as a vector of *Phytophthora* and other allied genera such as *Pythium* and *Nothophytophthora* (O'Hanlon et al. 2016; Bellgard et al. 2017).

Because of the variation in the types, depth, and permanency of the watercourses in and around the Project Site, a nested sampling approach was employed, utilising the traditional "stream-baiting" approach in areas of flowing water, as well opportunistic "grab-samples" from non-permanent, ephemeral pools, and "*soil sampling*" from points along the watercourse where there is no flowing or standing water.

Stream baiting from areas of flowing water
For the monitoring of perennial streams, traditional stream baiting was conducted using the sampling technique described by Randall (2011). Plant leaves (cedar and pine needles) were placed in plastic "bait-cassettes" and placed in the stream course for two-weeks. At each sampling location, there were two sampling cassettes, pre-loaded with fifteen cedar and pine needles, and linked together. The "bait-cassettes" were submerged in the stream at depth of 30 cm below the water surface and secured to one side of the bank. After two weeks the needles were removed from the cassettes, washed in water and frozen.

Grab-samples from "seasonal" streams and/or pools
In the absence of flowing streams, filtration of one litre "grab samples" of water was collected from each "pond". Filtration was validated as an effective method for detecting *P. ramorum* in streams in California where this pathogen previously had been recovered (Hwang et al. 2008). Filtration was found to be more effective and efficient than the "baiting method" for detection of diverse populations of *Phytophthora* species in forest streams.

Soil samples from areas of watercourse with no flowing or standing water
Watercourses still reflect a potential past and present risk pathway for the movement of phytophthora and so sampling still occurred in the absence of water. To maintain consistency in the approach, in areas where "*stream-baiting*" or "*grab sampling*" was not possible due to lack of water a soil sample was taken. A 250 g sample of the soil will be collected and assessed for phytophthora presence and identification.

A sample was taken at points where a watercourse intersects a project site boundary, construction boundary and buffer zone boundary. Additional samples were collected at 25 m (linear) spacings along the watercourse.

A map of the watercourse sampling locations is shown in appendix 5.

5.5 Track sampling

The phytophthora species being investigated spreads in soil and with soil if it is moved. Within known areas of phytophthora presence factors such as slope, host distribution and drainage are likely to be influencing the spread of phytophthora from the initial point of infection. These are factors which influence the rate of spread, vegetation infected and the overall size and shape of the affected area. However, evidence suggests that the highest risk vector for phytophthora movement into new distinct locations is soil disturbance associated with human activity.

Phytophthora agathidicida has been isolated from track soils as well as soil removed from tramping boots (Ian Horner *pers comm.* 2014; Pau'Uvale et al. 2011) and the risk associated with kauri dieback movement and track networks have been highlighted by reports produced by the Kauri Dieback Programme (Hill et al. 2012).

A 250 g soil sample was taken at points where a track intersects a project site boundary, construction boundary and buffer zone boundary. Additional samples were collected at 25 m (linear) spacings along the track.

A map of the track sampling locations is shown in appendix 6.

5.6 Animal disturbance sampling

Feral pigs have been implicated in the spread of *Phytophthora cinnamomi* in the O'hia forests of Hawai'i (Kleijunas and Ko 1976). Krull et al. (2012) identified that pigs have the capacity to spread *Phytophthora cinnamomi* on their trotters. Therefore, signs of fresh animal disturbance were surveyed and geo-referenced. Instances human-mediated disturbance (e.g. farm infrastructure) were sampled, as these may represent a historical pathway for soil movements.

A 250 g soil sample was taken from the point of disturbance, if the disturbance was longer than 25 m (for instance a sites of illegal driving across the site viewed on the site visit) then samples were taken every 25 m along the disturbance.

A map of the animal disturbance sampling locations is shown in appendix 7.

5.7 Sample processing and testing

The traditional bioassay for kauri dieback detection involves flooding and baiting of soil samples followed by plating of plant tissue baits onto phytophthora selective media and visual identification of the pathogen. Recent research (Winkworth et al. 2020) suggests that competition among co-occurring oomycetes (e.g., *Phytophthora* and *Pythium* species) on the selective media can result in failure to detect *P. agathidicida*. Other *Phytophthora* have faster *in vitro* growth rates than *P. agathidicida* and will therefore tend to overgrow *P. agathidicida* making visual detection of this species difficult. To overcome this potential limitation of the conventional "bait-n-plate" methodology Winkworth et al. (2020) instead implemented an isothermal loop-mediated amplification (LAMP) assay for the detection of *P. agathidicida*. The LAMP bioassay makes use of the same baiting procedure as the traditional bioassay but instead of plating the plant tissue baits, total DNA (i.e., DNA from the plant bait and colonising microbes) is extracted from the baits and subjected to testing using the LAMP assay. Published and unpublished testing (Winkworth et al., 2020; Winkworth *pers comm.*) indicates that detection rates for *P. agathidicida* are higher using the LAMP assay.

Soil samples
Baiting of soil samples was conducted under Physical Containment (PC) level 2 at Massey University, Palmerston North following a standard methodology for *P. agathidicida* (adapted form . The soils were first air-dried and then moist incubated for four days; the soils were then flooded with 500 ml of reverse osmosis (RO) water and five lupin four-day old lupin sprouts were floated on the water surface. After two days the lupin sprouts were removed; the radicals were removed using sterile technique, and immediately stored at -20°C.

DNA extractions and LAMP assays for *P. agathidicida* were carried out as described by Winkworth et al. (2020); for the present work tests were carried out on a Roche Lightcycler 480 II instrument rather than Diagenetix BioRanger devices as the former allow 96 samples to be tested simultaneously. Testing for *P. cinnamomi* was also conducted using a species-specific LAMP test (Winkworth et al., in prep). Each reaction set included multiple technical positive (i.e., DNA from known *P. agathidicida* or *P. cinnamomi* isolates) and negative (i.e., no DNA) controls. Additionally, sprouted lupin radicals, "baited" in RO water for two days were also included as "negative" controls.

Following baiting flooded soils were decontaminated using an MPI approved procedure (MPI ABTRT 2020).

Stream baits
Total DNA was extracted from frozen cedar and pine needle stream baits as described for soil tissue baits by Winkworth et al. (2020). Testing of bait DNA for *P. agathidicida* and *P. cinnamomi* followed the procedure described above for DNA from soil baits. Again technical positive and negative controls were included as well as DNA from cedar and pine needles not used for baiting.

Grab samples
Grab samples were vacuum filtered onto glass filters with 1.6 μm pore sizes; where necessary due to high sediment load two or three filters were used. DNA was extracted from up to one quarter of a filter using the Mackeray-Nagel Nucleospin Soil kit and Water DNA extraction kits. Testing of grab sample DNA for *P. agathidicida* and *P. cinnamomi* followed the procedure described above for DNA from baits. Again technical positive and negative controls were included.

6. Results

6.1 *Phytophthora agathidicida* and *P. cinnamomi* detections

The layered approach to sampling has led to a wide distribution of sampling locations across the entire site with a higher density of sampling in areas identified as higher risk of *Phytophthora agathidicida* presence. A map of all sampling locations is shown in appendix 8.

In total 996 samples were taken as part of the kauri dieback surveillance of the proposed water treatment plant site. Analysis detected *Phytophthora agathidicida* in 154 samples and *Phytophthora cinnamomi* in 128 samples (Table 1).

Table 1. Results of Phytophthora agathidicida and Phytophthora cinnamomi sampling across Watercare's proposed water treatment plant site and adjacent reserve.

Sampling layer	Number of samples	Number of *Phytophthora agathidicida* detections	Number of *Phytophthora cinnamomi* detections
Stratified sampling	273	26	5
Kauri rootzone sampling	461	83	108
Watercourse sampling	114	23	7
Track sampling	99	18	3
Animal disturbance sampling	49	4	5
Total	**996**	**154**	**128**

A map of the kauri health survey and complete site detection results is shown in appendix 9.

6.2 Stratified sampling

This generated 273 stratified samples across the site. Analysis detected *Phytophthora agathidicida* in 26 samples and *Phytophthora cinnamomi* in 5 samples.

A map of the stratified sampling detection results is shown in appendix 10.

6.3 Kauri rootzone sampling

In total 431 kauri sapling size and above were recorded during the surveillance:

- 190 were exhibiting no symptoms of kauri dieback.
- 184 were exhibiting ill-thrift
- 57 were exhibiting symptoms of kauri dieback

In addition, 15 kauri seedling clusters were recorded. No seedling clusters were exhibiting symptoms of kauri dieback.

Six young ricker kauri were recorded within the Extent of Works area.

A map of kauri and kauri dieback status shown in appendix 11.

Each of the individual kauri and seedling clusters were sampled resulting in 461 kauri rootzone samples. Analysis detected *Phytophthora agathidicida* in 83 samples and *Phytophthora cinnamomi* in 108 samples.

A map of the kauri rootzone sampling detection results is shown in appendix 12.

6.4 Watercourse sampling

The Project Site is in the headwaters of two Waituna Stream tributaries, including Armstrong Stream to the west and Yorke Stream to the east. Little Muddy Creek estuary is the receiving environment for the site. In addition to the streams a grid-based search of the area highlighted an additional 70 areas of standing/pooling water or areas where previous water movements were obvious.

This generated 114 watercourse samples across the site. Analysis detected *Phytophthora agathidicida* in 23 samples and *Phytophthora cinnamomi* in 7 samples.

A map of the watercourse sampling detection results is shown in appendix 13.

6.5 Track sampling

Exhibition Drive Track and Clarkes Bush Track transect the site. The grid search also highlighted an additional informal track network which appeared to have semi-regular use.

This generated 99 track samples across the site. Analysis detected *Phytophthora agathidicida* in 18 samples and *Phytophthora cinnamomi* in 3 samples.

A map of the track sampling detection results is shown in appendix 14.

6.6 Animal disturbance sampling

The grid search discovered no signs of pig or large animal presence within the site. 49 instances of animal disturbance were recorded, and all of these were associated with humans, mainly associated with pest management activities.

This generated 49 animal disturbance samples across the site. Analysis detected *Phytophthora agathidicida* in 4 samples and *Phytophthora cinnamomi* in 5 samples.

A map of the animal disturbance sampling detection results is shown in appendix 15.

6.7 Positive and negative control samples

The investigation tested 6 'positive controls' using soil samples collected from a private property in the local area with previously confirmed area of *Phytophthora agathidicida*. Analysis detected *Phytophthora agathidicida* in all 6 samples and *Phytophthora cinnamomi* in 5 samples.

The investigation tested 2 'negative controls' using baits floated on water with no soil. Analysis did not detect *Phytophthora agathidicida* or *Phytophthora cinnamomi* in either of the samples.

6.8 Detection buffering

Although sampling for kauri dieback in non-kauri areas has not previously been conducted on this scale, it is accepted practice that for site management purposes such as the works proposed for the development of the water treatment plant, a 30 m buffer is applied to the point of *Phytophthora agathidicida* detection. A map of *Phytophthora agathidicida* and *Phytophthora cinnamomi* detections with a 30 m buffer is shown in appendix 16.

7. Conclusions

A field survey confirmed the presence of kauri dieback symptoms within the Project Site, and surrounding buffer within Clarks Bush.

Analysis of soil samples detected the presence of *Phytophthora agathidicida* and *Phytophthora cinnamomi* in soil taken from the Project Site, and adjoining buffer area within Clarks Bush.

Analysis of water samples detected the presence of *Phytophthora agathidicida* and *Phytophthora cinnamomi* in water taken from the Waituna stream tributary network within the Project Site, and adjoining buffer area within Clarks Bush.

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9. Appendix

Appendix 1 – Selected bibliography of this team's kauri dieback related outputs

Technical reports

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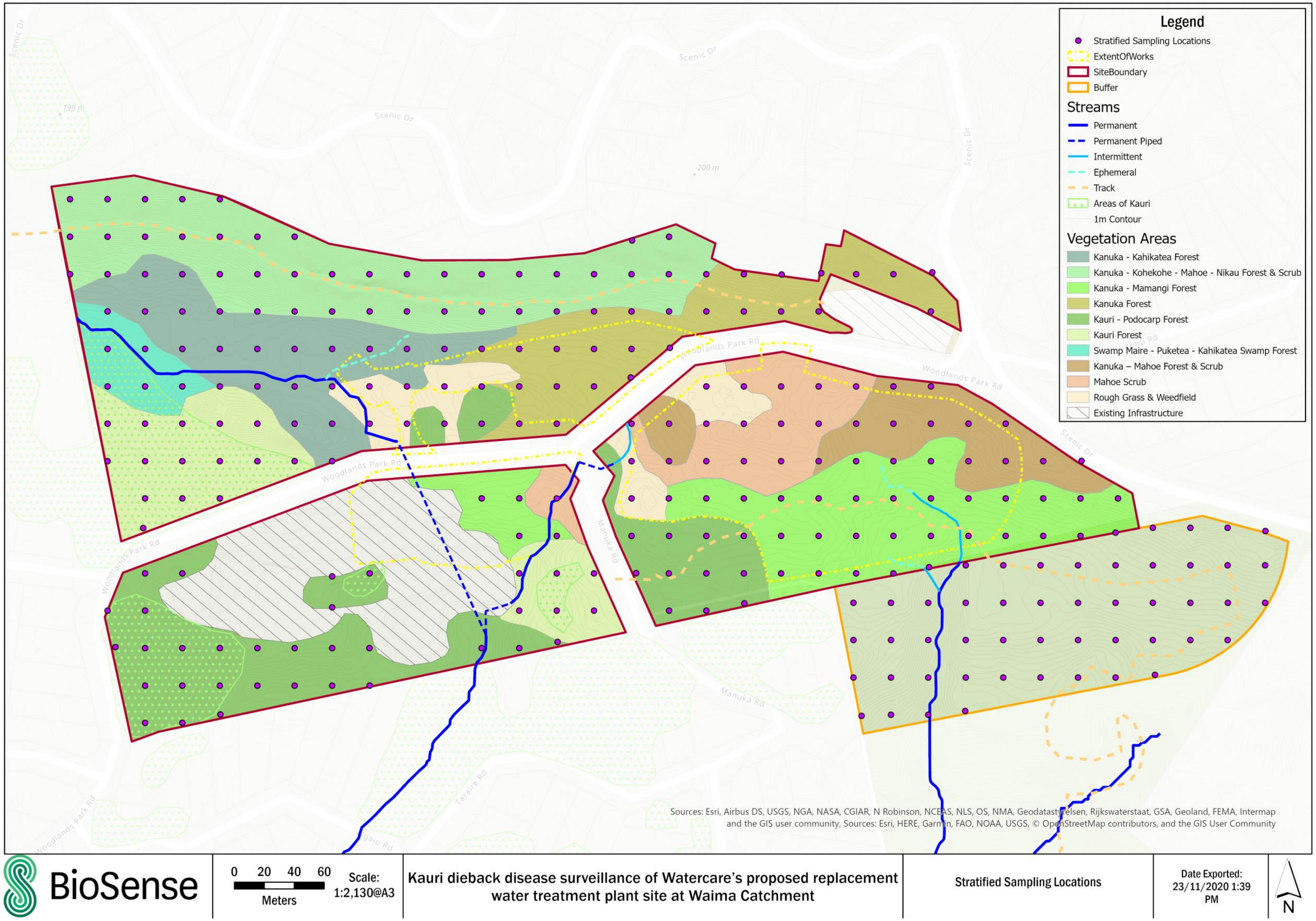
Appendix 2 – Selected bibliography of this team's kauri dieback related outputs

This team has carried out or have been involved in all the kauri dieback surveillance projects across since 2010 including, but not limited to, the following:

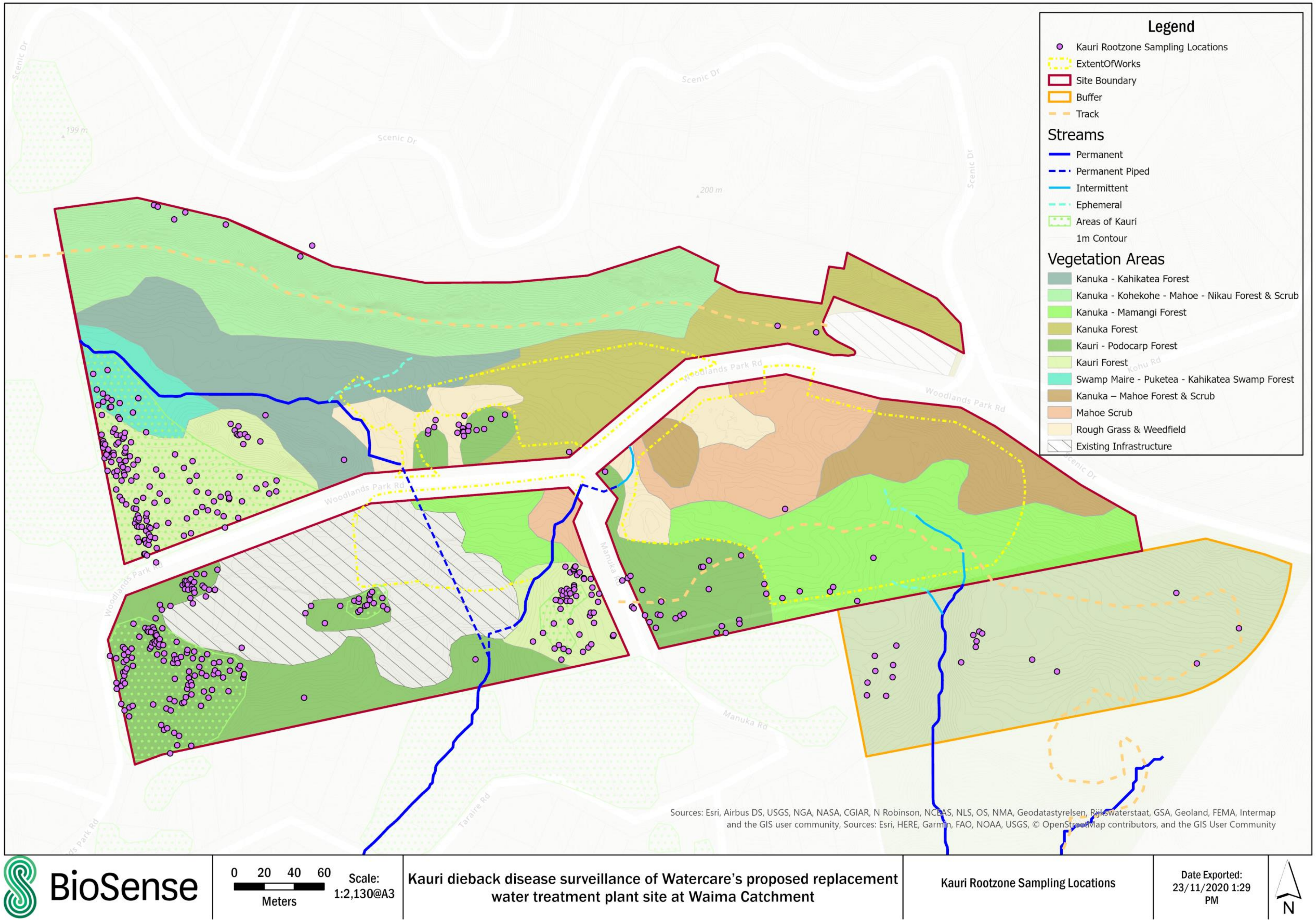
2010 – Investigation into kauri dieback symptomology and design of survey parameters.
2010 to 2018 – Design and implementation of Auckland Council's active kauri dieback surveillance plan.
2010 to 2018 – Design and implementation of Auckland Council's passive kauri dieback surveillance plan.
2010 – Aerial surveillance of Waitakere Ranges.
2010 – Groundtruthing and sampling of Waitakere Ranges.
2011 to 2012 – On-track survey of kauri health along the track network across Auckland Council-managed parks.
2014 – Aerial surveillance of Waiheke and Ponui Islands.
2015 – Design of RFP for PDH student to investigate the use of multispectral surveillance a tool for kauri dieback detection.
2015 – Technical support for investigation of the use of multispectral surveillance.
2015 – Field support for investigation of the use of multispectral surveillance.
2015 to 2018 – Progress review of investigation of the use of multispectral surveillance.
2016 – Aerial surveillance of Waitakere Ranges.
2016 to 2017 – Groundtruthing and sampling of Waitakere Ranges.
2016 to present – Designed, sort funding for and implemented Kauri Rescue.
2017 – Aerial survey of Hunua Ranges and Awhitu Peninsula.
2017 – Groundtruthing and sampling of Hunua Ranges and Awhitu Peninsula.
2018 – Aerial survey of Northern Auckland.
2018 – Groundtruthing and sampling of Northern Auckland.
2018 – Identification of kauri dieback with 60m of Tane Mahuta, Waipoua Forest.
2019 – Northland Kauri Cone Collection project as part of the Healthy Trees, Healthy Future programme.
2019 – Phosphite treatment and survey of kauri dieback area in Coromandel.
2019 – Phosphite treatment and survey of kauri dieback area in Auckland.
2019 – Groundtruthing and sampling of 170 potential kauri dieback sites across Northland.
2019 – Groundtruthing and sampling of 20 potential kauri dieback sites across Coromandel.
2020 – Phosphite treatment and survey of kauri dieback area in Coromandel.
2020 – Groundtruthing and sampling of potential kauri dieback sites across DOC land in Northland

This does not include the numerous workshops, events and seminars on kauri dieback and kauri dieback surveillance.

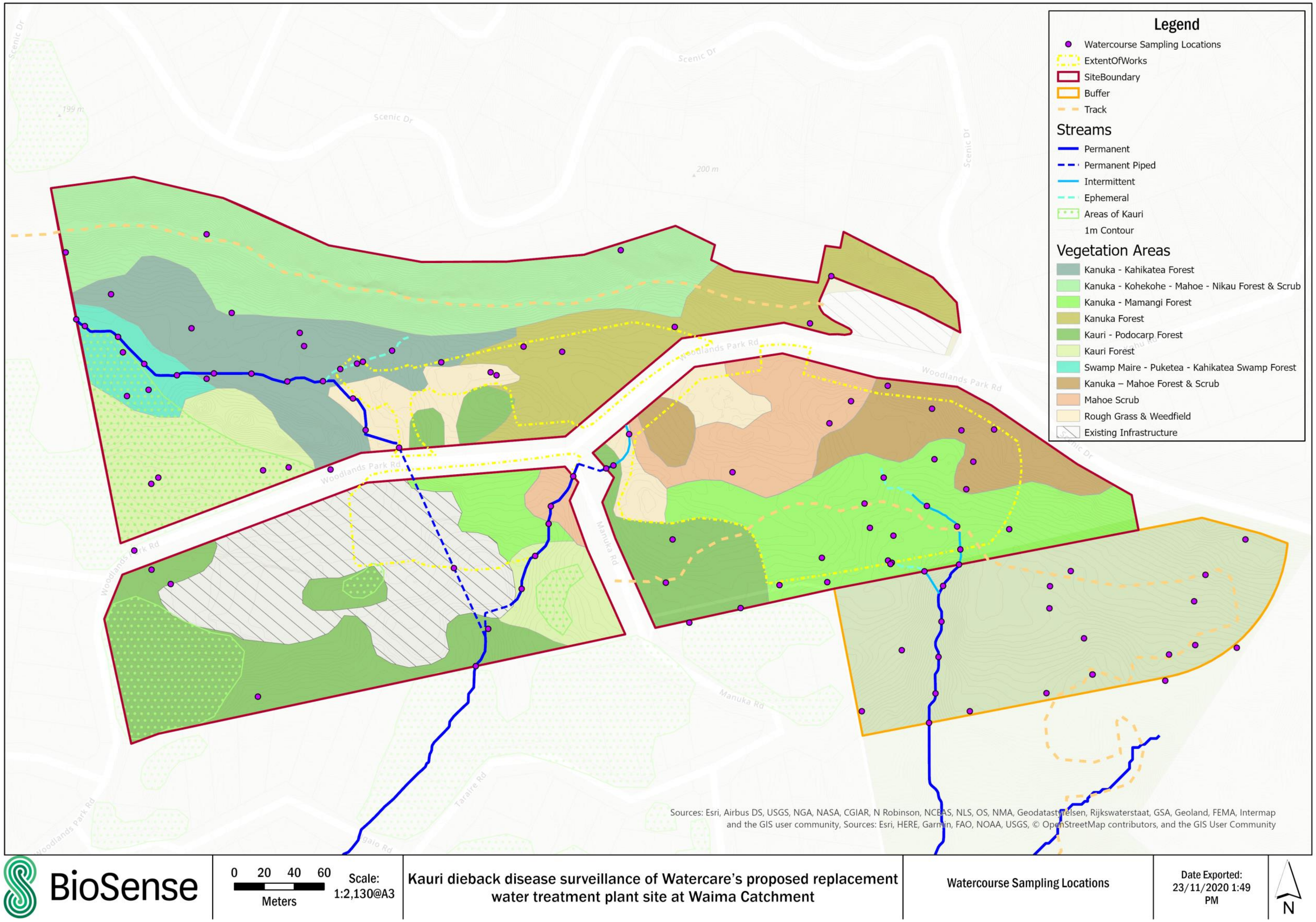
Appendix 3 – A map of stratified sampling locations



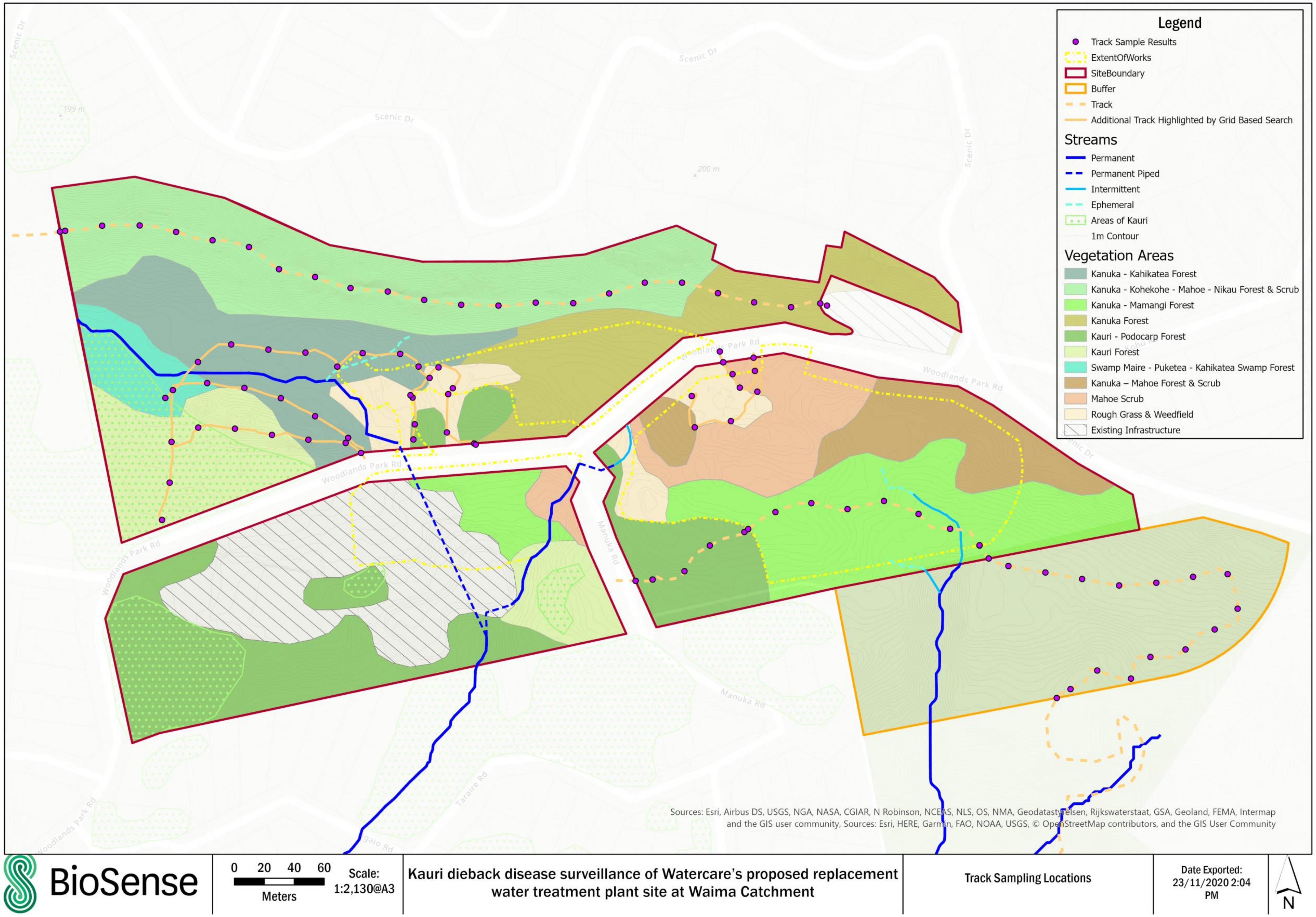
Appendix 4 – A map of the kauri rootzone sampling locations



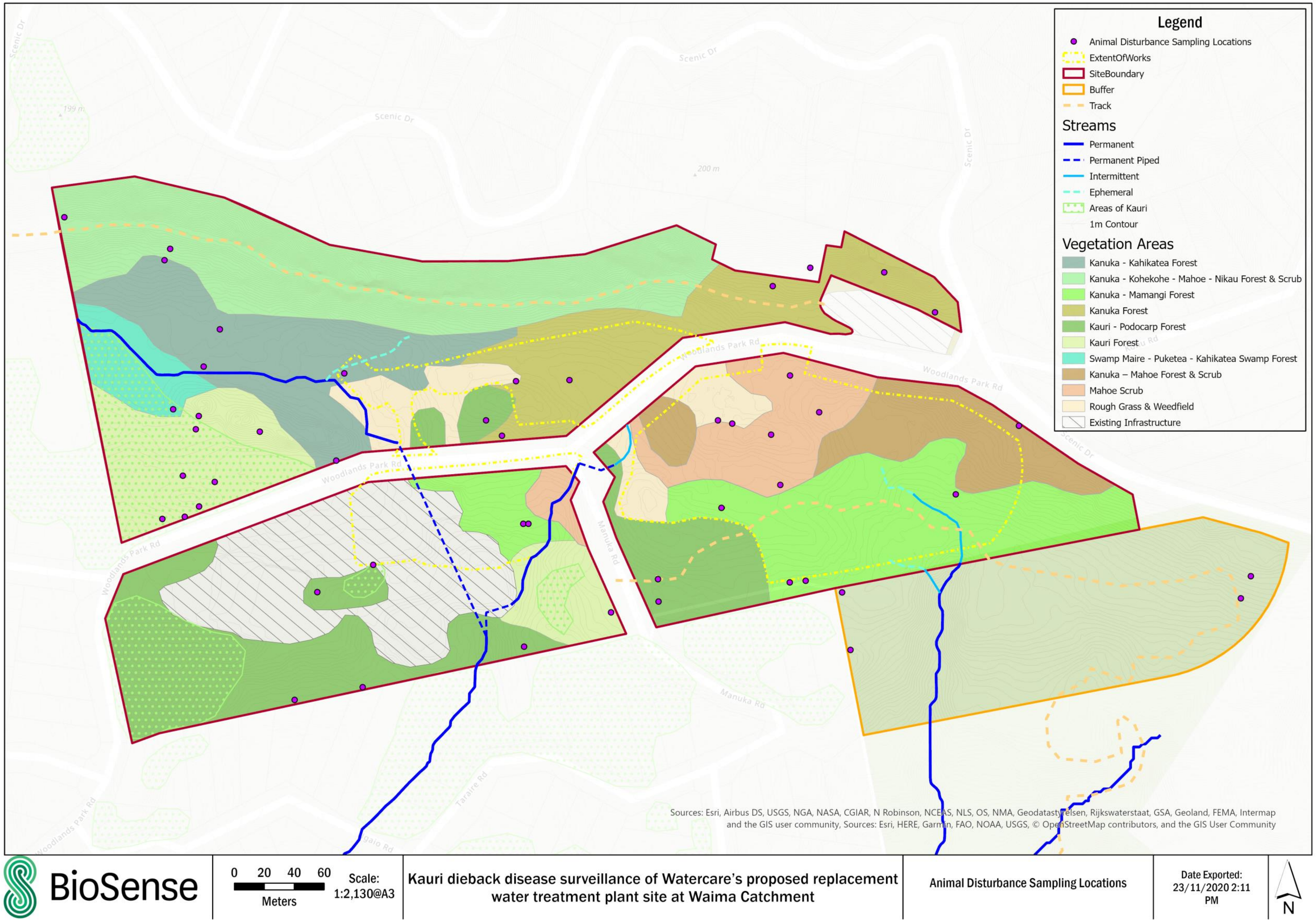
Appendix 5 – A map of watercourse sampling locations



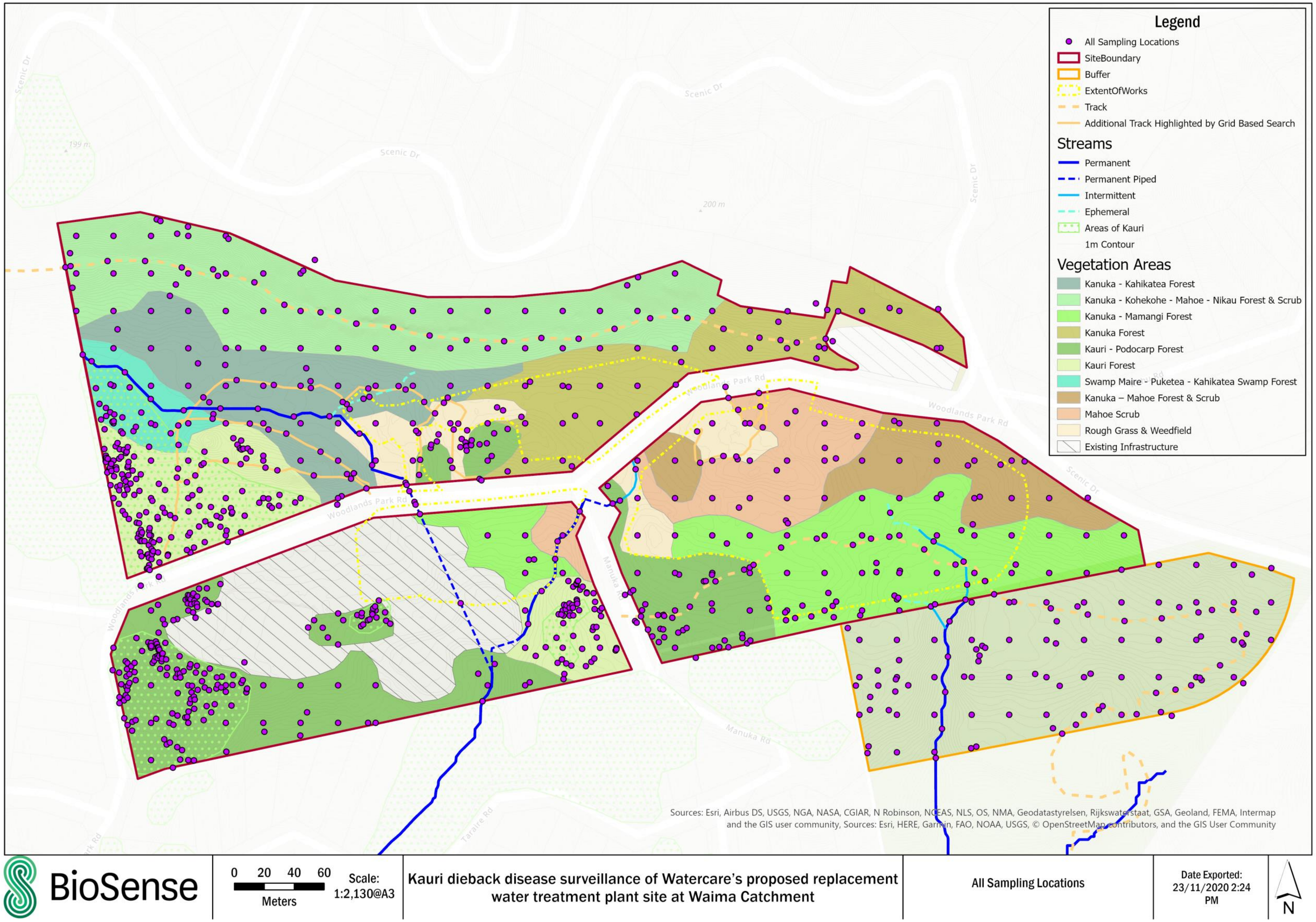
Appendix 6 – A map of the track sampling locations



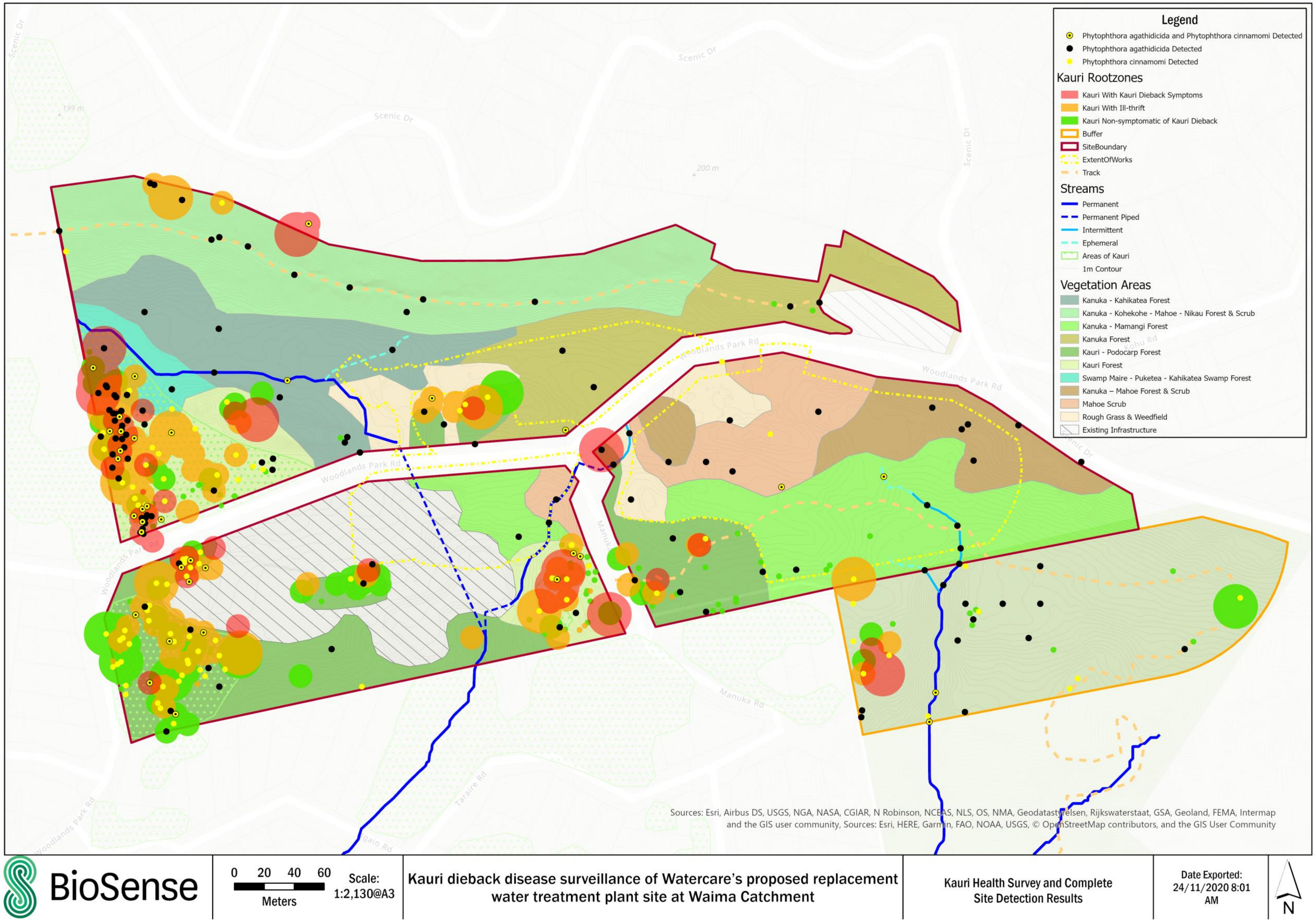
Appendix 7 – A map of the animal disturbance sampling locations



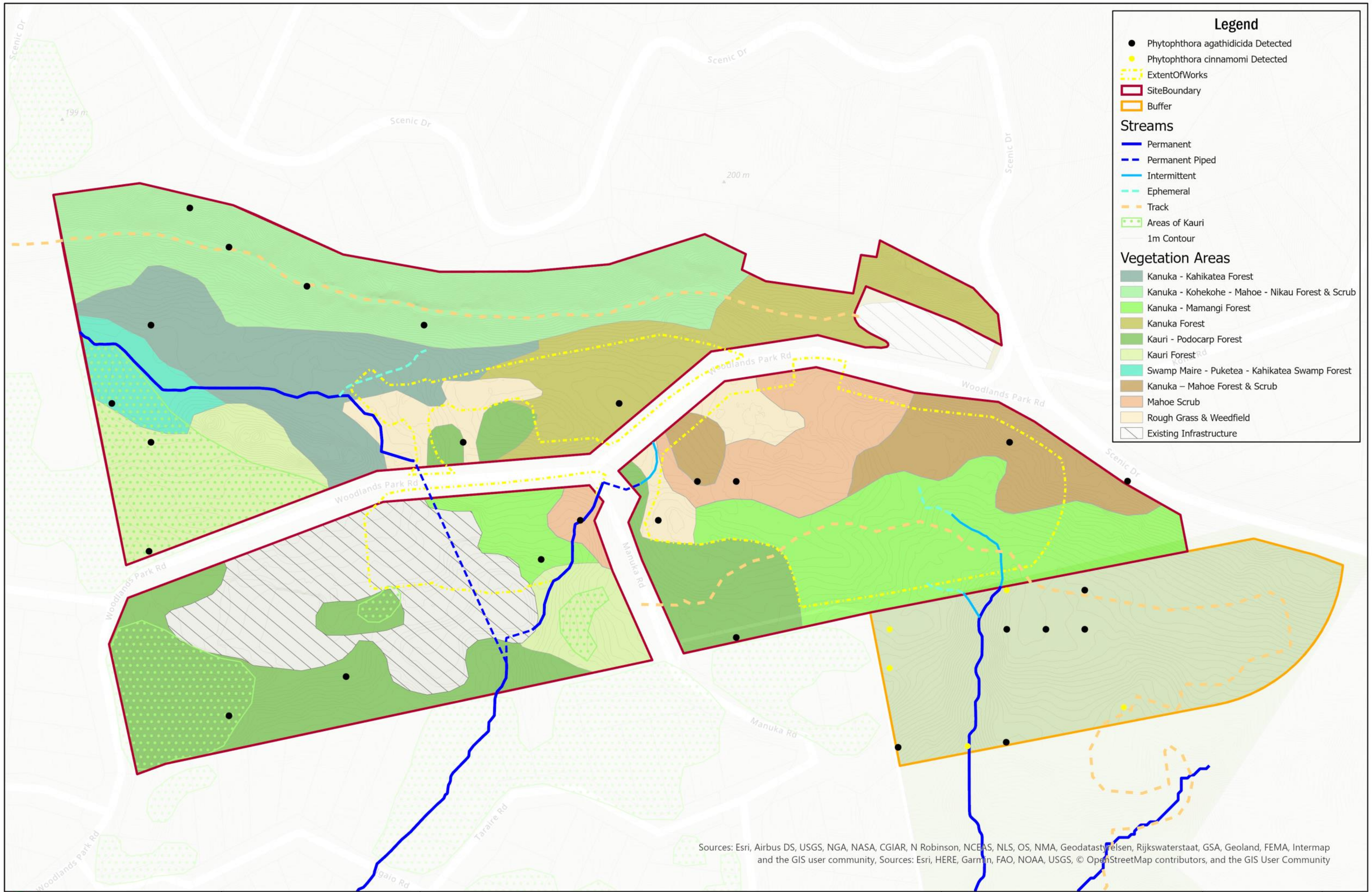
Appendix 8 – A map of all sampling locations



Appendix 9 - A map of the kauri health survey and complete site detection results

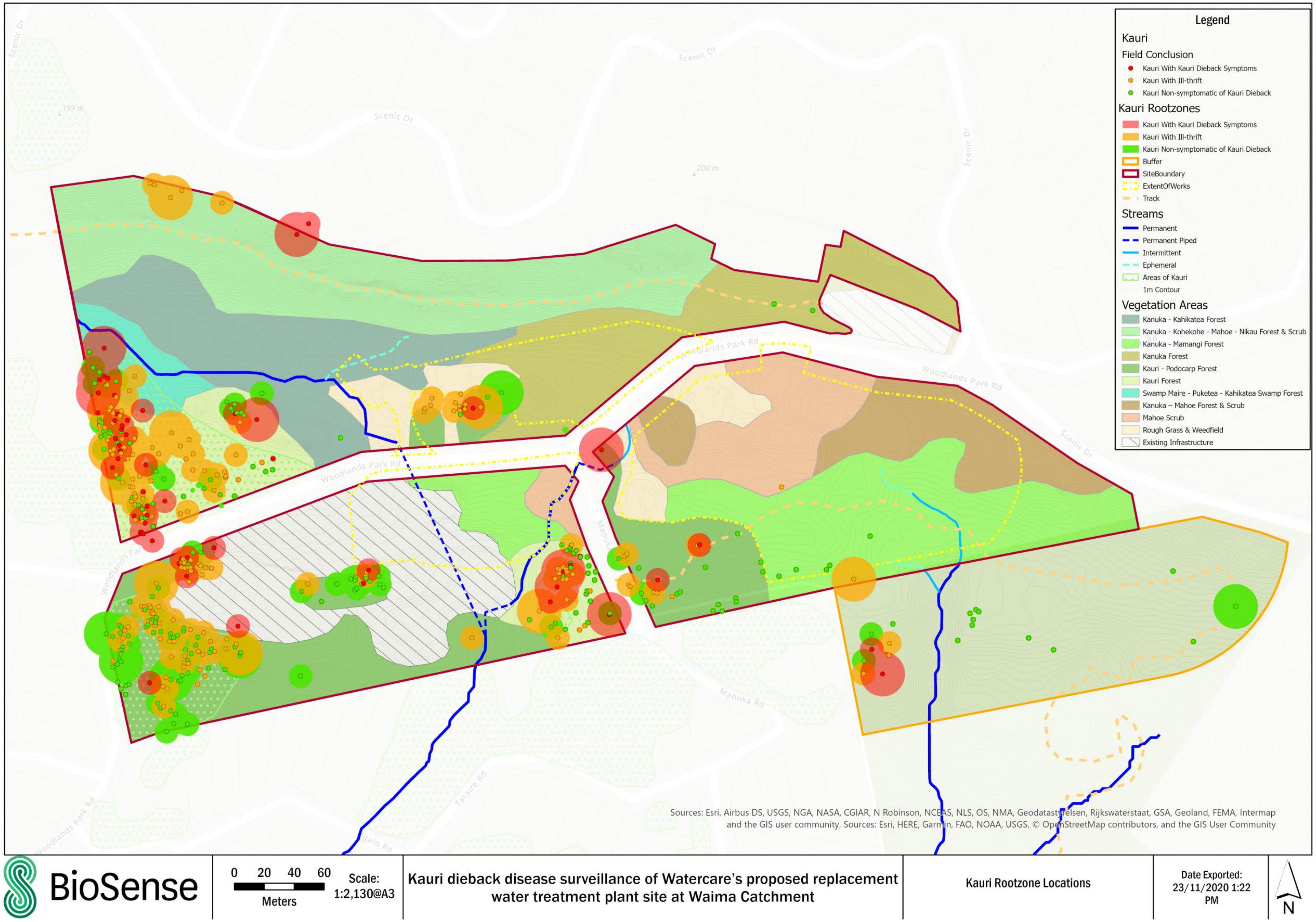


Appendix 10 - A map of the stratified sampling detection results

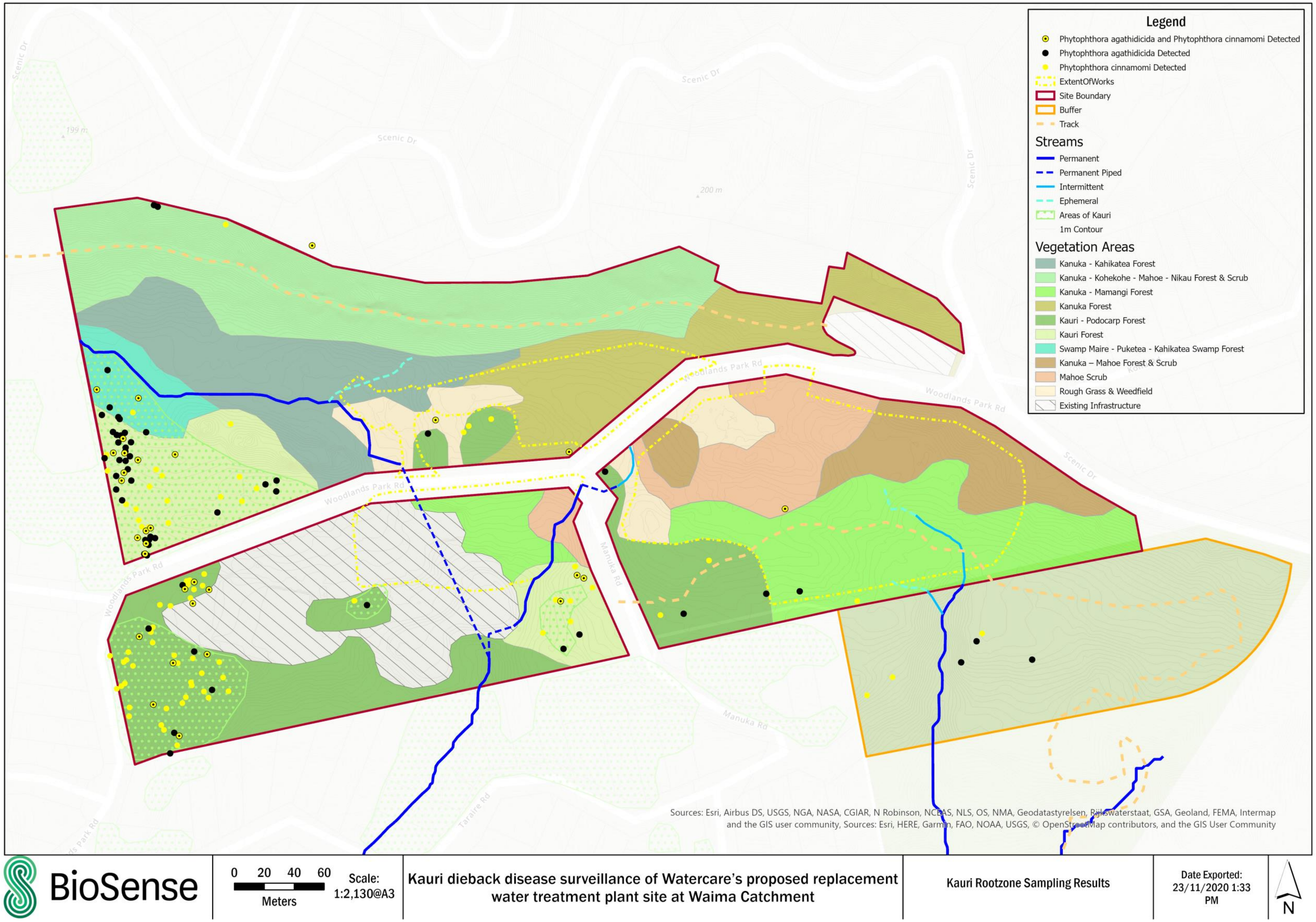


BioSense	0 20 40 60 Meters Scale: 1:2,130@A3	Kauri dieback disease surveillance of Watercare's proposed replacement water treatment plant site at Waima Catchment	Stratified Sampling Results	Date Exported: 23/11/2020 1:42 PM	N

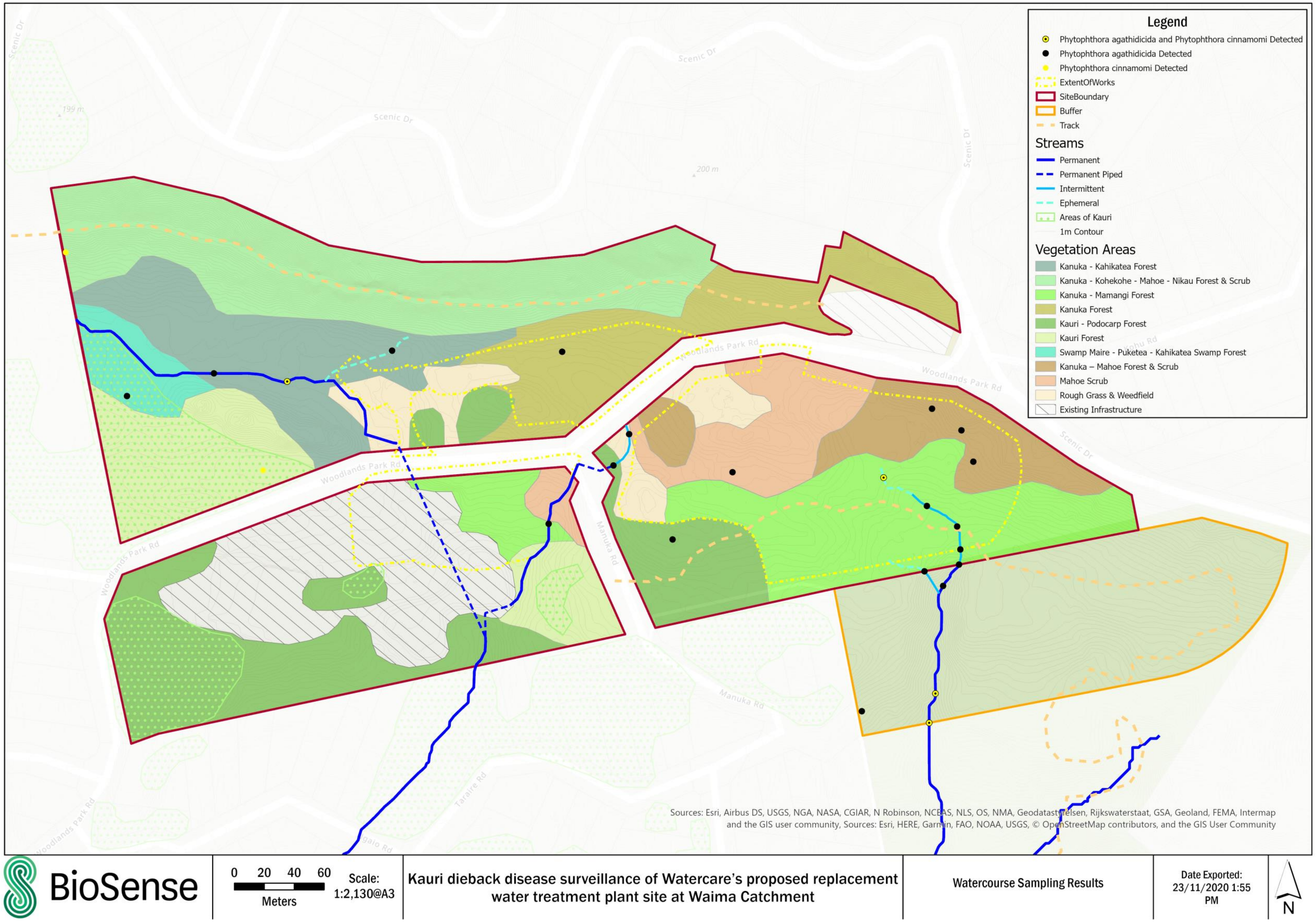
Appendix 11 – A map of kauri and kauri dieback status



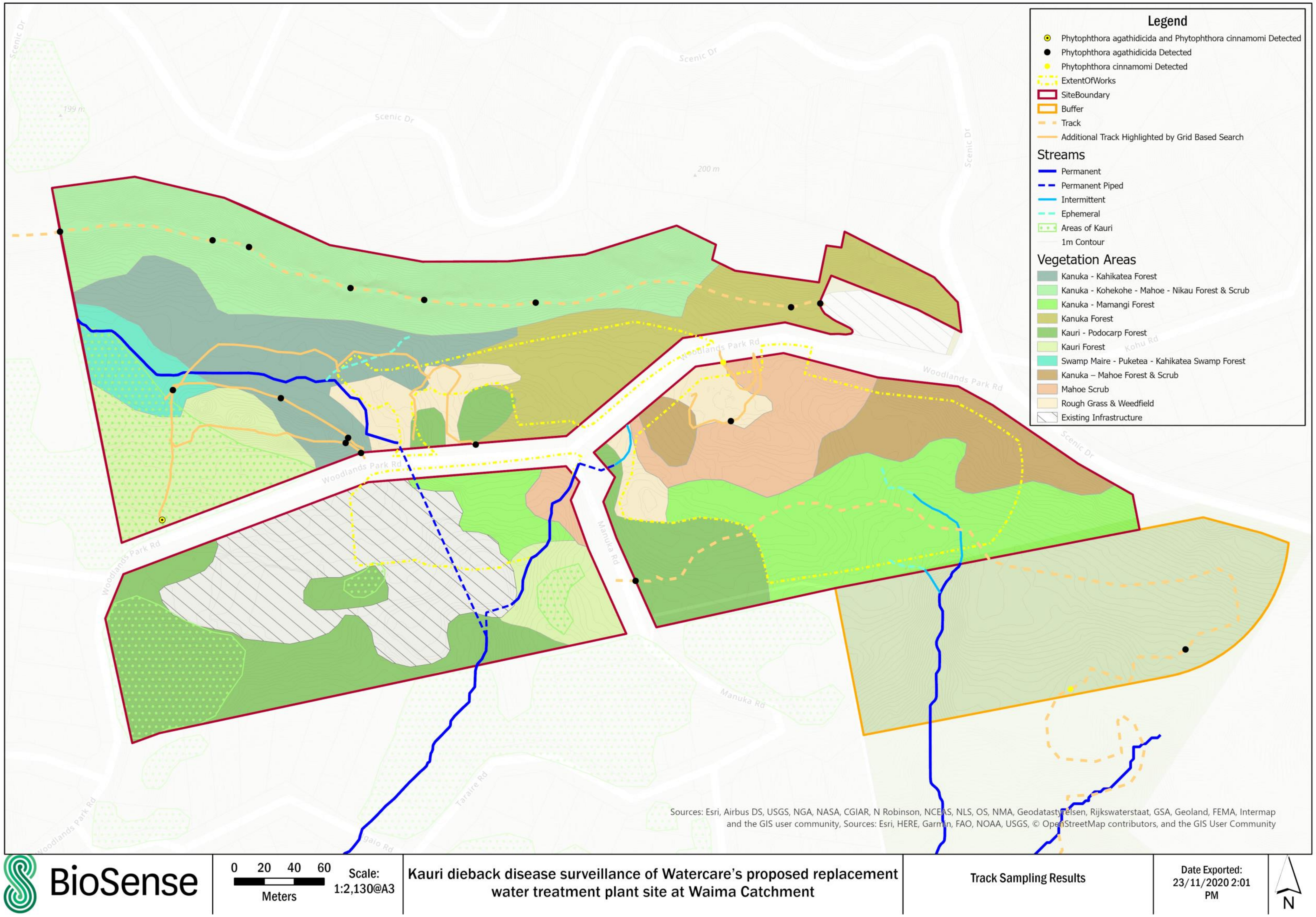
Appendix 12 - A map of the kauri rootzone sampling detection results



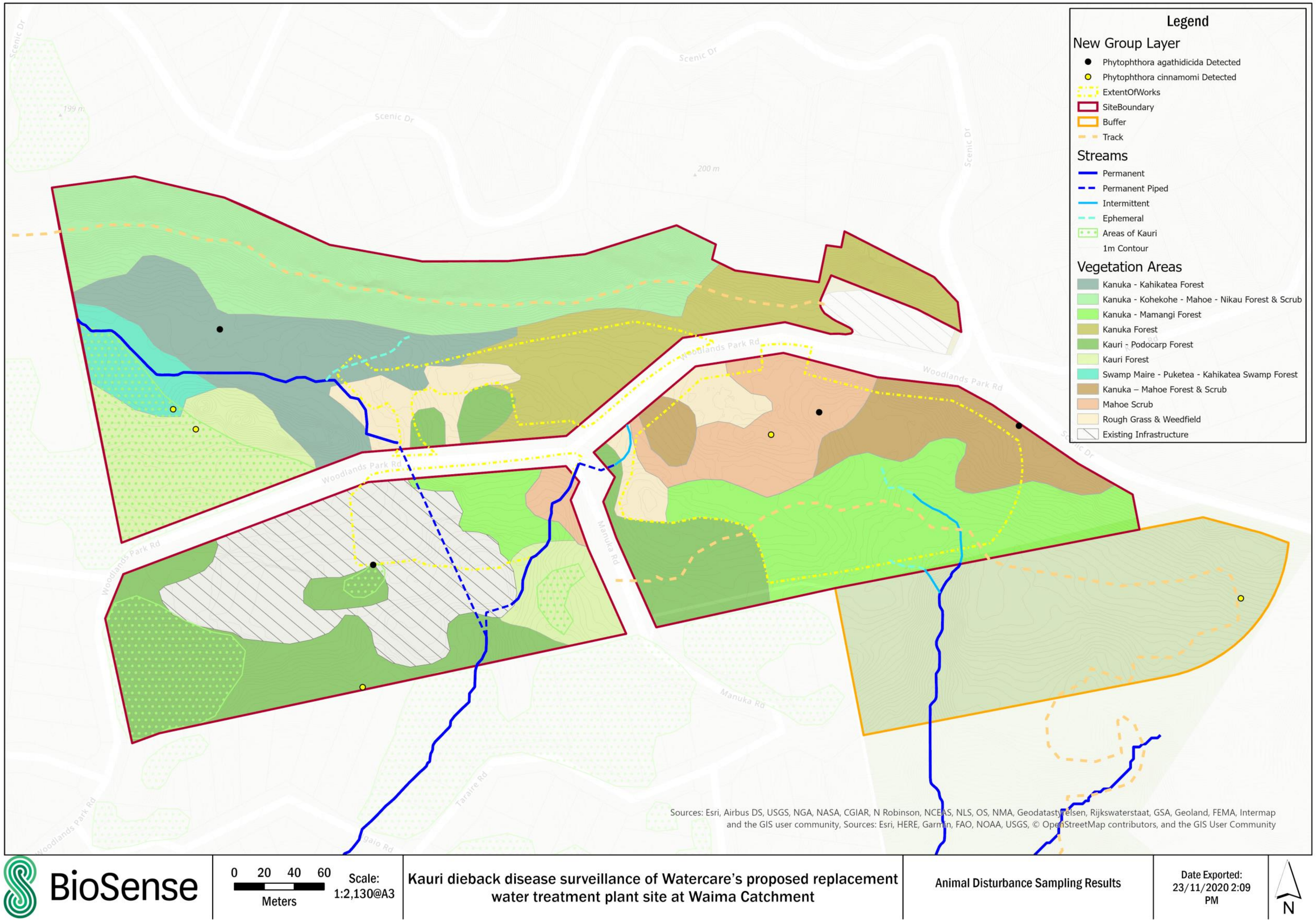
Appendix 13 – A map of the watercourse sampling detection results



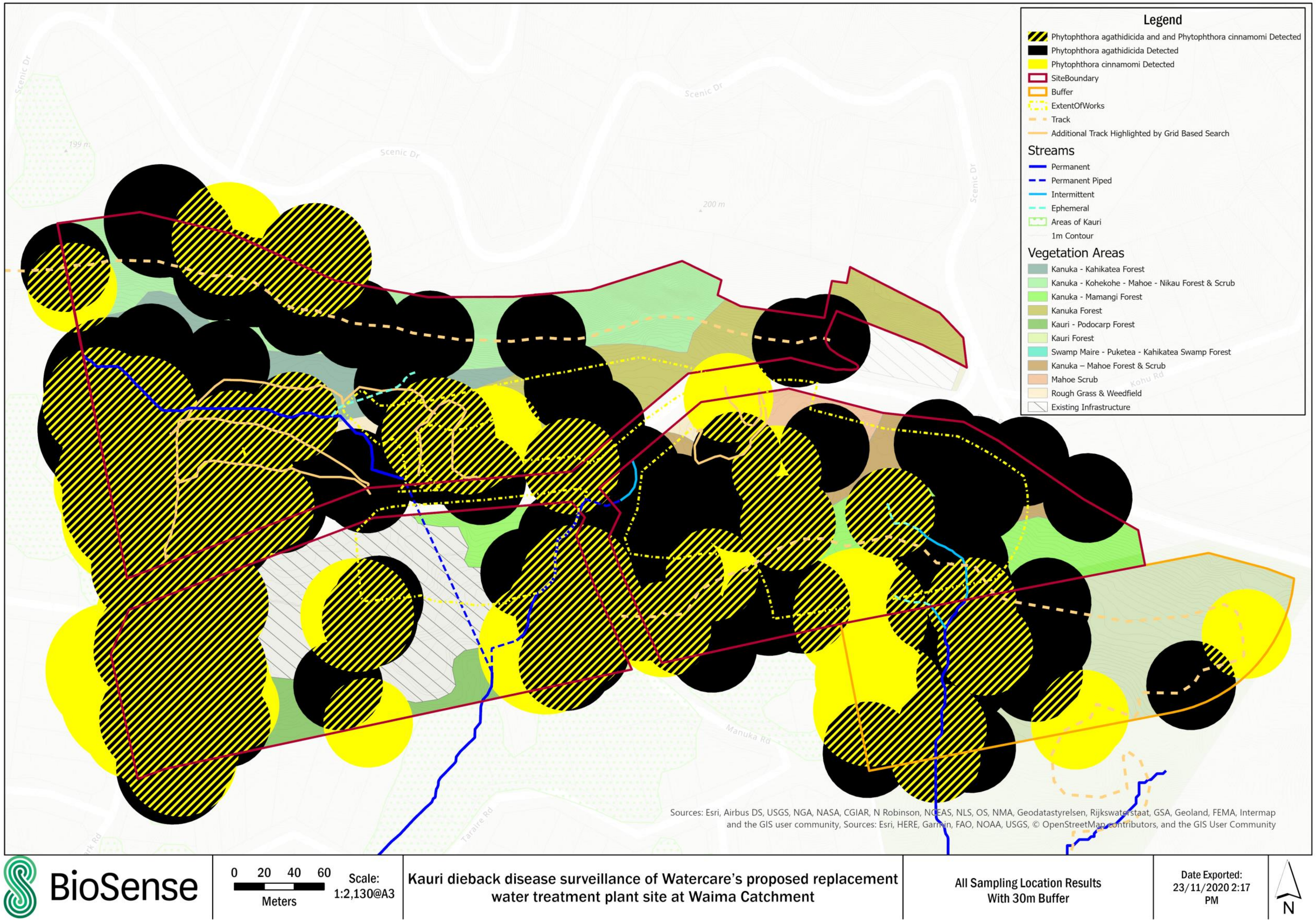
Appendix 14 – A map of the track sampling detection results



Appendix 15 - A map of the animal disturbance sampling detection results



Appendix 16 - A map of *Phytophthora agathidicida* and *Phytophthora cinnamomi* detections with a 30 m buffer



Boffa Miskell

Kauri Dieback Management Plan

Replacement Huia Water Treatment Plant, Waima
Prepared for Watercare Services Ltd.

Document Quality Assurance

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	Campbell McGregor Engineer Harrison Grierson	
Reviewed by:	[**TO COMPLETE**] [Title / Position] Boffa Miskell Limited	
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CONTENTS

Appendices

1.0 Introduction

1.1 Project Description

Watercare operates water supply dams within the Waitākere Ranges, including the Upper and Lower Huia Dams and the Upper and Lower Nihotupu Dams. The Huia Water Treatment Plant (Huia WTP, named for the source of the water) is located in Waima and treats the water from these dams before it is distributed via the water transmission network.

The Huia WTP was constructed in 1929 and is now nearing the end of its operational life (90 years old). Watercare therefore proposes to construct a new WTP to replace the aging Huia WTP. As part of this project Watercare is also proposing to construct two treated water reservoirs (50ML total capacity) to increase treated water storage within the western supply zone.

The project is located on land owned by Watercare and is designated in the Auckland Unitary Plan (AUP) for 'Water supply purposes – water treatment plants and associated structures' (designation reference 9324 – Huia and Nihotupu Water Treatment Plants). The project spans three sites owned by Watercare which have a total site area of 15 ha. The land parcel on which the proposed replacement Huia WTP is located has an area of approximately 4.2 ha, the proposed Reservoir 1 land parcel is approximately 6.4 ha, and the existing WTP site (within which Reservoir 2 is proposed) is approximately 4.0 ha.

The works footprint is 4.3 ha in total, 3.5 ha of which comprises indigenous forest and scrub. The Project Site forms part of a 24,000 ha Significant Ecological Area (SEA_T_5539 in the Auckland Unitary Plan (AUP) - Operative in part) that encompasses much of the Waitakere Ranges. The Project Site is located in the headwaters of two Waituna Stream tributaries, including Armstrong Stream to the west and Yorke Stream to the east.

Based on current estimates of earthworks required for the project, approximately 75,000m³ of cut and 42,000m³ of fill is required across the site. Approximately 40,000m³ of the cut material is from the excavation associated with the construction of Reservoir 1. The main WTP site is close to an earthworks balance and the Reservoir 2 has a shortfall of 5,000m³.

1.2 Kauri Dieback Disease Characteristics

Phytophthora agathidicida is the pathogen regarded as a primary causal agent of dieback disease in otherwise healthy kauri, while other *Phytophthora* species may also have a role in the expression and severity of disease symptoms. Kauri dieback infects trees through their roots, and spreads primarily through the movement of contaminated soil and water, as well as by root-to-root contact between trees.

Mapping and surveillance has established that there are at least 344 distinct areas of kauri ecosystem within the Waitakere Ranges, and about 33% of these areas have kauri dieback or possible kauri dieback symptoms present.

Previous surveillance work (Hill et al., 2017) identified that kauri dieback infections showed a strong association with tracks and watercourses, and human activity and disturbance is assumed to be a key vector of the disease.

The kauri dieback pathogen has two types of propagule. The oocyte is formed within infected tissue and released into the soil where it can remain latent for an indefinite period. Soil movement is a key mode of dispersal of this type of propagule. The oocyte is resistant to sterigene and other disinfectants.

Ultimately, the oospore germinates and produces zoospores which can ‘swim’ through micropores in saturated soil, and in this way actively disperse themselves. In this form, the pathogen finds and infects tree roots. The zoospores can be destroyed with disinfectant.

Sources and locations of kauri dieback pathogen are:

- Infected tree roots of kauri;
- Parts of the forest floor and waterbodies where oospores have been dispersed;
- Moist, porous soil layers where motile zoospores have emerged and dispersed.

Mineral sub-soil layers below the root zones of vegetation are at lower risk of contamination relative to organic soil layers, as inorganic parts of the substrate are not porous and do not contain living plant material.

1.3 Kauri Dieback within the Project Site

The Assessment of Ecological Effects report for the proposed replacement WTP development (Boffa Miskell 2019) identified the risk of kauri dieback spread as a management issue, as potentially symptomatic kauri trees were observed within the Project Site. Stands of kauri occur within the Project Site, and nice mature kauri are present immediately adjacent to the works footprint. No mature kauri are located within the works footprint itself. Six kauri seedlings and saplings have been found within the WTP footprint, most in the vicinity of large trees near the southern boundary outside the WTP footprint.

A public walking track from Manuka Road through the Watercare land, that is the proposed site for the replacement Huia WTP, to Clarks Bush reserve was frequently used prior to its closure in 2017. Kauri forest interspersed with residential development dominates the broad ridgelines immediately southward of the Project Site.

2.0 Management Plan Approach

2.1 Overall purpose

The purpose of this Management Plan is to minimise the risk of spreading kauri dieback disease in the process of constructing the replacement WTP and reservoirs. This includes controlling movement of any potentially contaminated material on machinery, footwear, equipment or via surface runoff to minimise the risk of spreading the pathogen into uninfected areas.

Containment, removal and disposal of infected topsoil from the site to minimise the risk of kauri dieback spread during bulk earthworks is a key focus of this management plan.

P. agathadicida was not detected in a number of kauri trees sampled within in the Project Site and adjacent reserve. Management measures also include protection of the root zones of these trees to prevent damage which may increase the likelihood of infection.

2.2 Management Approach

Management of kauri dieback disease risk for the replacement WTP project has the following components:

1) Comprehensive soil testing across the Project Site to inform knowledge and assumptions regarding the current presence and distribution of kauri dieback disease pathogens in the area.
2) Staging and detailed specifications for geotechnical investigations, vegetation clearance and systematic removal and disposal of surface soil layers from the development footprint prior to undertaking enabling earthworks. Works specifications will minimise the risk that any potentially infected material is discharged or moved offsite in an uncontrolled manner. This includes measures to contain overland flows of stormwater, and offsite soil disposal to appropriate facilities to ensure these are equipped for the level of infection risk.
3) Containment and wash facilities and hygiene protocols to prevent site workers and machinery moving soil offsite and between work areas.

Fundamental to the success of this management plan is ensuring the proposed approach is practicable during construction. To ensure the staged and systematic approach set out in this management plan is achievable during construction, the methodology was developed in collaboration with construction contractors, erosion and sediment control experts and project ecologists.

The detailed indicative staging set out in the accompanying staging plans (Appendices 1 and 2) has been developed based on site topography, access requirements for construction machinery, space required for erosion and sediment control devices, site optimisation from a construction perspective to avoid the need for stockpiling during the topsoil removal phase of works, or the need for vehicle access through areas yet to be disturbed. Consequently, the accompanying staging plans reflect a realistic and practicable approach to construction in a constrained site while ensuring the requirement to minimise the risk of spreading kauri dieback disease is achievable.

2.3 Soil Testing

A field testing protocol to assess the presence and distribution of kauri dieback causing pathogens (specifically *Phytophthora agathidicida*, and also including *Phytophthora cinnamomi* was developed and implemented (Biosense 2020).

The objective of sampling was to assess:

1. The disease status of kauri trees within and surrounding the proposed works footprint.
2. The presence and distribution of phytophthora in soil within the Project Site and adjacent buffer.

3. The presence of *Phytophthora* within the adjacent reserve, focusing on likely infection pathways such as walking tracks, watercourses and areas of standing water, and sites of human and feral animal disturbance.

Sample collection and analysis methods sought to maximise detection probability, in order to give the best chance that kauri dieback-causing pathogens would be detected if present within the construction footprint and wider Project Site.

Sample analyses used a combination of LAMP assay and qPCR detection methods for *P. agathadicida* and *P. cinnamomi,* rather than a traditional bioassay method as this novel method has been shown to produce more precise and repeatable results (Winkworth et al 2020).

Testing (Biosense 2020) has confirmed the presence of *P. agathadicida* within the Project Site, and while infections are more concentrated in stands of mature kauri located away from the works footprint, sporadic detections in soil and watercourses away from kauri specimens were found throughout the Project Site, including within the works footprint. A similar pattern of distribution was found in the adjacent portion of Clarks Bush reserve that was sampled, and several detections were found along the Exhibition Drive walking track which is still open to the public. Another disease-causing pathogen, *P. cinnamomi,* was also detected within stands of mature kauri.

2.4 Site Protocols

As outlined above, the spread or movement of Kauri Dieback primarily occurs through contaminated soil or surface water. Therefore, the applicable management functions are those that control and/or mitigate the movement of soil and surface water during construction operations.

Soil testing has confirmed that *P. agathadicida* is prevalent throughout the Project Site, therefore comprehensive hygiene protocols are required for all work areas. The protocols have been split into five sub-sections which relate to the works phases outlined below.

The following sections should be considered in conjunction with the indicative staging plans contained within Appendices 1 and 2 of this report. While the staging is indicative, the objectives and specifications of the staging plans should be adhered to. These objectives and specifications are summarised below and described in sections 3 to 7.

Prior to Site Works\General

- Washdown Facilities (Vehicle and Personnel)
- Separate bootwash facilities at KCZ entry
- Washwater collected and contained onsite until it can be sterilised or disposed of offsite
- Delineation of earthworks/ native vegetation boundary
- Delineation of Kauri Containment Zones (KCZ)
- Imported hardfill direct from quarry of KD free catchment.

Geotechnical Assessments

- Form access tracks (geoweb or hardfill)

Vegetation Clearance

- Extension of access tracks (geoweb or hardfill)
- Renewal of stabilised entry and clean out and renewal of wash down facilities
- Any works within KCZ to be contained and machinery cleaned prior to entry
- Restricted Staging of Vegetation Clearance 0.1-0.2ha
- Cleared areas to be bunded with mulch/kanuka brush/fascines

Surface Soil Removal

- Renewal of stabilised entry and clean out and renewal of wash down facilities
- Localised sediment controls with downstream surface water containment
- Limit staging up to 3000m²
- Allow larger exposed areas in accordance with GD05 and best practice
- No stockpiling of material
- Disposal of material to approved facility licensed to receive such material
- Specific KCZ measures apply

Bulk Earthworks

- Clear delineation and control or runoff between surface soil removal and bulk earthworks catchments
- Specifications for cut and fill materials

3.0 Prior to Site Works

The following infrastructure and protocols are to be established before any vegetation clearance, soil disturbance, vehicle or machinery movement on the Project Site.

- A wash facility for vehicles, machinery, equipment and footwear is established at all entry and exit points on the Project Site. The facility is to include a truck washdown with shaker ramp or approved equivalent to enable collection of all sediment and surface water from the wash down process. Wash water is to be collected and contained on-site until it can be sterilised or disposed of utilising a sucker truck (or to trade waste).

- Kauri containment zones (KCZ) encompassing 3 times the crown radius of all kauri trees (figure 1) will be fenced and indicated with appropriate signage wherever these extend into the construction footprint. All KCZ fencing should include signage every 15m to 20m. An arborist will determine and mark out the actual extent of the kauri root zone prior to any earthworks within each KCZ, and the extent of the KCZ will be extended if required to encompass all kauri roots. Silt fencing on a 300mm high bund will be used, as this will assist in redirecting any surface water flow away from the KCZ, and prevent excavated soil entering or exiting the KCZ in an uncontrolled way.
- Boot and equipment wash facilities are to be installed at entry point to all KCZs within the construction footprint.
- Silt fencing will be installed along the boundary of the construction footprint where it adjoins native vegetation to be retained. Silt fencing will help prevent excavated soil spilling into areas outside the construction footprint.

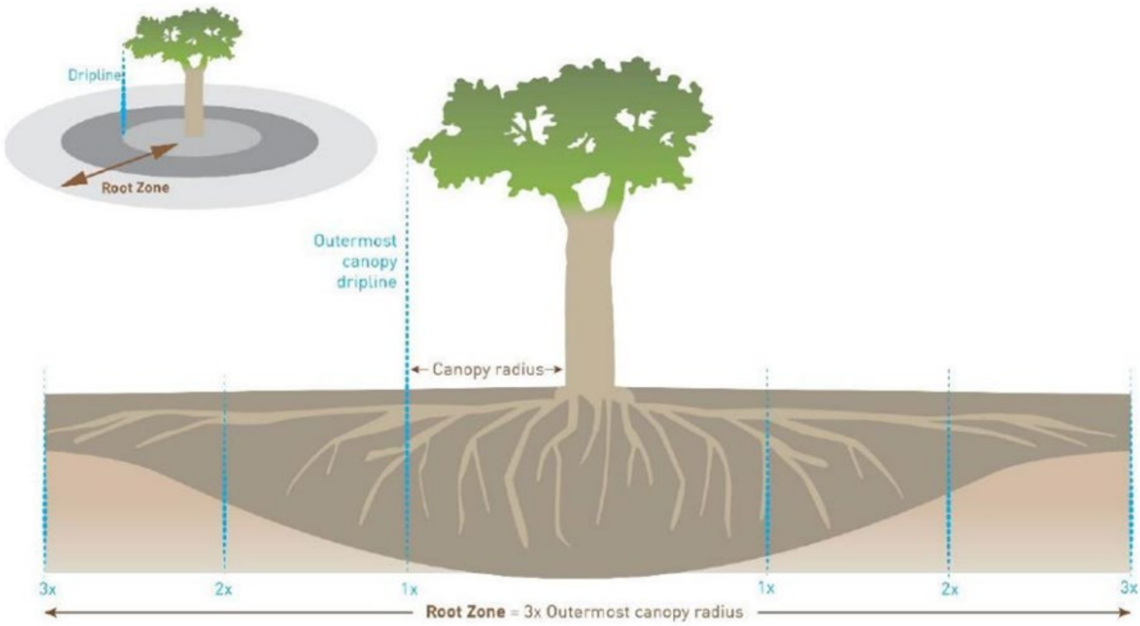

Figure 1. *Diagram showing root zone of kauri (3 times the radius of the outermost canopy dripline)[1]. Kauri trees don't have a defined taproot (Bergin & Steward, 2004) and most of the roots occur near the soil surface. Anchoring 'peg' roots can extend to a depth of 5m.*

- Silt fences will be installed as per Section F1.3 of the Auckland Council Guideline Document GD2016/005. Before site works commence, the Project Ecologist will inspect the silt fences and confirm with the Site Manager that the fences have been installed as per the specifications above.
- Any issues with the fence installation will be communicated to the Site Manager to ensure the issues are resolved. The Project Engineer will need to confirm in writing that the fences are installed correctly before any site works commence.

[1] Figure sourced from https://www.kauridieback.co.nz/media/2018/bpg-quarry-hygiene_v14_final-signed2.pdf.

- Access tracks (e.g., Geoweb and/or hard fill) are to be installed to enable machinery to move through the site for geotechnical investigations and vegetation clearance without contacting bare soil.

4.0 Geotechnical assessments

4.1 Description of Works

Geotechnical assessments are required prior to the detailed design of the replacement WTP. Localised vegetation clearance is required to enable geotechnical equipment access to test sites. The following objectives and principles will be implemented to minimise soil disturbance and control movement of soil for the purposes of Kauri Dieback containment. Vegetation cleared for geotechnical investigations will be retained on-site.

4.2 Objectives

The following objectives apply to this phase of works:

- Minimise site disturbance. Avoid significant trees and minimise vegetation removal only creating adequate corridors to form necessary access tracks and area to conduct tests.
- No grubbing or tree stump removal.

4.3 Specifications

- Appendix 1 scheme plans show indicative geotechnical sample locations and accessways. Access tracks will be stabilised with geoweb and hard fill prior to use. Final access track routes will be marked on the site following site walkovers to determine the least extent of clearance.
- A stabilised site entry and washdown facilities will be installed at site entry\egress points prior to commencement of works.
- All material imported to site must be either hardfill direct from a quarry (no recycled hardfill) or from a kauri-free catchment.
- The wash facility for vehicles, machinery, equipment and footwear is to be used at each entry and exit of personnel, vehicles and machinery to the Project Site. No entry or exit to or from the Project Site will occur anywhere except through the designated access points.
- All footwear, tools and equipment must be totally soil-free when entering and exiting the Project Site. Equipment (including footwear) should be cleaned and sprayed with Sterigene disinfectant (or equivalent).
- As far as possible, works are to be undertaken in dry weather to reduce soil adhering to vehicles and equipment.

- Trees felled during this phase are to be cut at the base to avoid grubbing or tree stump removal. Tree canopies are to be left onsite for clearance as part of the following site-wide phase.

5.0 Site-Wide Vegetation Clearance

5.1 Description of Works

Site wide vegetation clearance will be carried out systematically to enable fauna checks to be undertaken, as detailed in the Ecological Management Plan. The following controls will be implemented to minimise soil disturbance and control movement of soil for the purposes of Kauri Dieback containment.

5.2 Objectives

The following objectives apply to this phase of works:

- Minimise site soil disturbance.
- No grubbing or tree stump removal.
- Staged, systematic clearance across the site (refer Appendix 1)
- Limit work areas to 0.1 – 0.2ha at any one time.

5.3 Specifications

- Site access for machinery will be via formed tracks previously established for geotechnical investigations, and renewed/ extended as required.
- Stabilised entry will be renewed where necessary, and wash down facilities cleaned out, following geotechnical investigation phase.
- The wash facility for vehicles, machinery, equipment and footwear is to be used at each entry and exit of personnel, vehicles and machinery to the Project Site. No entry or exit to or from the Project Site will occur anywhere except through the designated access points.
- All footwear, tools and equipment must be totally soil-free when entering and exiting the Project Site. Equipment (including footwear) shall be cleaned and sprayed with Sterigene disinfectant (or equivalent).
- Wash down of footwear and equipment used within a KCZ should occur within the KCZ. Any equipment and machinery brought into a KCZ must be clean. Soil attached to machinery that has operated within a KCZ must be removed prior to exiting the KCZ, and cleaned in the wash-down facility prior to exiting the Project Site.

- All material imported to site must be either hardfill direct from a quarry (no recycled hardfill) or from a kauri-free catchment.

- Vegetation clearance will be staged (refer Appendix 1) and undertaken in 0.1 – 0.2 ha patches, to minimise the extent of disturbed ground exposed at any one time.

- Cleared areas are to be bunded with mulched woody material/ kanuka brush/ geotextile cloth in the interim between vegetation clearance and topsoil removal, as far as possible utilising material that has been felled onsite.

- Surface water that accumulates within the excavation and has been in contact with disturbed organic soils shall be allowed to drain to ground. Wood chip and fascines of kanuka scrub will be used to bund open workings. All work surfaces shall be stabilised at the end of a working day if rainfall is anticipated to limit erosion.

6.0 Surface Soil Removal

6.1 Description of Works

Systematic sampling of soil detected *P. agathadicida* in sporadic locations throughout the proposed works footprint. All topsoil is therefore to be treated as potentially infected. Topsoil and any other potentially infected matter to a nominal depth of 0.5 m, plus a further 0.5 m of subsoil[2] to extend well below the root zone, will be excavated in a staged manner and removed from site to minimise the risk of spreading Kauri Dieback disease into uninfected areas during bulk earthworks. It is this 1m of material that will be subject to the controls described as surface soil removal. Current estimates are that approximately 22,000m³ of topsoil is to be removed from site.

Mineral sub-soil layers below the root zones of vegetation are at low risk of contamination relative to organic soil layers[3], as inorganic parts of the substrate are not porous and do not contain living plant material.

During the process of topsoil removal, external catchment surface flows will be directed away from the works areas, while dirty water will be collected and treated for sediment at source within decanting earth bunds. Discharge from the decanting earth will then be conveyed to a separate stormwater containment facility. The containment facility will be sized to contain surface runoff from the exposed catchment area in any storm event up to a 1 in 10-year event. Following sterilisation of the surface water runoff, water will then be discharged over a 24 hour period from the containment facility to the downstream channel/stream.

[2] In all instances the actual depth will vary across the site. The Project Arborist is to supervise works and advise the necessary depth required for removal.

[3] Soil bioassays (Bellgard et al., 2013) from excavated root systems of diseased kauri confirmed the presence of *P. agathicida* in surface soil layers where roots were concentrated, but no *Phytophthora* species were recovered below a depth of 20 cm.

6.2 Objectives

The following objectives apply to this phase of works:

- Limit areas of soil disturbance to 3000m².
- Provide controls on the majority of catchments to mitigate sediment loss and contain surface water run-off.
- Collect and dispose of sediment from control devices post completion of the phase to an approved facility.
- Decanting earth bunds shall be designed to provided 3% live storage as opposed to 2% (GD05) to increase the storage volume and improve sediment retention.
- The surface water run off containment basin shall be utilised to capture surface run off from the exposed catchment area allowing for water to be "treated" prior to discharge. The basins shall be sized to contain the full 1 in 10-year storm event flow from the exposed (3000m²) earthworks catchment.

6.3 Site-Wide Hygiene Specifications

The following controls will be implemented during the staged removal of surface soil layers for the purposes of Kauri Dieback containment.

- Stabilised entry will be renewed where necessary, and wash down facilities cleaned out, following the vegetation clearance phase.
- The wash facility for vehicles, machinery, equipment and footwear is to be used at each entry and exit of personnel, vehicles and machinery to the Project Site. No entry or exit to or from the Project Site will occur anywhere except through the designated access points.
- All footwear, tools and equipment must be totally soil-free when entering and exiting the Project Site. Equipment (including footwear) should be cleaned and sprayed with Sterigene disinfectant (or equivalent).
- All works to be done with localised stormwater and sediment controls (as per staging plans, Appendix 2).
- Drainage and storm water run-off from the Project Site is to be diverted away from KCZs.
- Surface soil layers will be progressively removed, and the cleared area stabilised, as per catchment staging plans (Appendix 2).
- Where material is suitable for reuse onsite this shall be prioritised in lieu of disposal.
- Topsoil is to be loaded directly onto trucks (no stockpiling), covered and then transported for offsite disposal. All soil material removed from the Project Site must be disposed of to an offsite facility (as approved by Auckland Council).
- All material imported to site must be either hardfill direct from a quarry (no recycled hardfill) or from a kauri-free catchment.

6.4 KCZ Specific Measures

The following additional specific controls will apply to Kauri Containment Zones:

- Soil removal works within KCZs are to be progressively excavated inwards towards the tree root zone, and infilled with hardfill hardstand. All soil and organic material from within KCZs must be disposed of to an appropriately licenced landfill facility (as approved by Auckland Council's KDB Specialist).

- All material imported to site must be either hardfill direct from a quarry (no recycled hardfill) or from a kauri-free catchment.

- Wash down of footwear and equipment used within a KCZ should occur within the KCZ. Any equipment and machinery brought into a KCZ must be clean. Soil attached to machinery that has operated within a KCZ must be removed prior to exiting the KCZ, and cleaned in the wash-down facility prior to exiting the Project Site.

- Once KCZ organic matter and subsoil have been removed, and the areas covered with geotextile or hardstand material, vehicles and machinery can move between the KCZ and the wider project site without the above restrictions on movement, provided no further soil is disturbed within a KCZ.

6.5 Soil Removal and Disposal

Removal of potentially infected soil and organic matter from the site is to be undertaken with the following protocols:

- Transport vehicle trailers should have sealed sides (or liners installed) to ensure all loads being transported is appropriately contained and leakage from soil or debris is reduced during transit. There may be situations where this is not practical, however every care should be taken to reduce the risk of soil or debris from falling off the transport vehicle.
- Liners should be of a suitable thickness and durability to prevent rupture during transport and contain the material sufficiently to prevent any leakage. The liners can be folded over to encompass the entire load and then appropriately secured.
- The vehicle (including trailer unit) shall be sprayed after unloading with a solution containing 2% Sterigene solution either at the landfill (if available) or back at the depot prior to re-use. Liners must be appropriately disposed of.
- Soil disposal records (summaries) shall be kept for later validation reporting, if necessary.

7.0 Bulk Earthworks

7.1 Description of Works

Systematic removal of surface soil layers will reduce the possible extent and potential likelihood that Kauri Dieback disease is present within the construction footprint, hence for the bulk earthworks phase hygiene protocols are proposed to occur at each construction site boundary only. Further, while topsoil and bulk earthworks are occurring concurrently in different catchments across the site, stormwater and sediment control measures will be put in place to avoid cross contamination of runoff from topsoil disposal catchments.

Once all topsoil earthworks are complete and only bulk earthworks are occurring across the site, standard erosion and sediment practises will apply.

7.2 Objectives

The following objectives apply to this phase of works:

- Ensure surface runoff from bulk earthworks catchments is discharged without cross contamination of runoff from the topsoil disposal catchment(s).

7.3 Specifications

- The wash facility for vehicles, machinery, equipment and footwear is to be used at each entry and exit of personnel, vehicles and machinery to the Project Site. No entry or exit to or from the Project Site will occur anywhere except through the designated access points.
- All footwear, tools and equipment must be totally soil-free when entering and exiting the Project Site. Equipment (including footwear) should be cleaned and sprayed with Sterigene disinfectant (or equivalent).
- Wash water is to be collected and contained on-site until it can be sterilised or disposed of.
- Wash water cannot be re-used or recycled within the wash station unless sterilised.
- Under no circumstances is any soil material resulting from the earthworks to be deposited outside of the silt fences.
- Any damage to silt fences will be remedied promptly.
- Drainage and storm water run-off from the construction site is to be diverted away from KCZ.
- Where material is suitable for reuse onsite this shall be prioritised in lieu of disposal.
- Cut material from the Bulk Earthworks phase that requires disposal will be carted to a clean fill disposal site. While this material is assumed to be free of kauri dieback pathogens, the disposal location shall not be within a catchment that contains Kauri trees.
- All material imported to site must be either hardfill direct from a quarry (no recycled hardfill) or from a kauri-free catchment.

8.0 Roles and Responsibilities

8.1 Site Manager

It is the Site Manager's responsibility to:

- Ensure all contractors are informed of the relevant protocols included in this document;
- Ensure that contractors and consultants understand that entry into and exit from the project site triggers kauri dieback control protocols;
- Undertake ongoing monitoring and repairs of the exclusion and silt fences which will be installed as part of the site preparation;
- Carry out and document daily and 'inclement weather' inspections of sediment and runoff controls around the works site and remediate issues identified;
- Undertake random audits of construction and environmental personnel to ensure compliance with the work protocols specified in this management plan.

8.2 Project Engineer

It is the Project Engineer's responsibility to:

- Review and assist the contractor in designing and maintaining compliant earthworks controls in accordance with the KDMP and consent conditions.
- Conduct periodic inspections of the installed control measures to ensure ongoing compliance.
- Provide instruction and oversight to ensure adequate hold points are stipulated and observed so that the KDMP principles are achieved.

8.3 Project Arborist

It is the Project Arborist's responsibility to:

- Identify driplines and root zones of all kauri trees in the vicinity of the works footprint.
- Confirm final location and supervise installation of KCZ fencing and signage;
- Supervise any earthworks within the KCZ to ensure damage to the root zone of any kauri tree is avoided, or in the case of the "knoll kauri tree", manually excavate and prune tree roots in advance of earthworks.
- Advise as to the appropriate depth of excavation to ensure all organic soil and root material from the site is excavated and disposed of appropriately and oversee the works.

8.4 Project Ecologist

It is the Project Ecologist's responsibility to:

- Inspect and sign off the site preparation as described in this management plan prior to earthworks commencing;
- To promptly communicate any issues with site preparation to the Site Manager so the issues can be remedied, prior to commencement of works; and
- To assist the Site Manager with audits and training as required.

9.0 Communication

9.1 Training and induction

Ensuring all contractors are aware of the potentially severe impacts of kauri dieback disease how it is spread, and effective prevention measures is key to promoting compliance with this Kauri Dieback Management Plan.

The Site Manager is to induct all personnel upon their first entry to the site. The following points should be included in all site inductions:

1. The background of Kauri Dieback disease; the organism that causes it and how it infects kauri;
2. The fact that Kauri dieback is present on the site, and locations where it has been detected;
3. The impacts of Kauri Dieback Disease on kauri and the wider forest ecosystem;
4. How the disease is spread, noting that small fragments of contaminated soil can spread the disease;
5. That there is no known cure for Kauri Dieback Disease, and if *Phytophthora agathidicida* is introduced to an ecosystem it is not currently possible to eradicate it;
6. The hygiene procedures each contractor is required to undertake and how these procedures will help keep the work site and its surrounds free of kauri dieback.

Training in hygiene procedures will be undertaken as part of the induction process for new personnel when they enter the site. Training will emphasise individual and collective responsibility for making sure equipment is completely clean of soil, and step through site entry and exit procedures to ensure these are clear and unambiguous.

9.2 Signage

Signage will be placed around wash stations and the site office to reinforce the hygiene procedures outlined in the training.

All KCZ will be appropriately marked with signage every 15m to 20m alerting personal of the KCZ.

10.0 Monitoring

10.1 Entry and exit from site

The Site Manager will be responsible for ensuring that all vehicles, equipment and machinery are being appropriately washed with Sterigene (or equivalent) upon entry into the Project Sites, and that wash stations are kept clean, maintained and in working order.

10.2 Sediment Controls

The Site manager is responsible for daily inspections to ensure the effectiveness of containment and erosion control measures (bunds, geotextile covers, wood chip, brush fascines, etc) implemented around both the active works area and treated areas during the process of topsoil stripping. A checklist of observations and accompanying site photographs will be compiled, including (but not limited to):

- conditions - wet/ dry/ dusty
- any bare soil exposed
- any flowing water observed
- integrity of fencing and other containment structures

Any issues identified are to be immediately remedied and documented with photographs.

10.3 Weather Events

Weather forecasts are to be closely monitored during site works to ensure the work site is adequately closed, covered and bunded during rainfall events. Bunds downslope of active works are to be inspected during any rain event in the course of vegetation clearance and topsoil removal, and immediately remedied if breaches are identified.

10.4 Soil testing for *P. agathadicida* [TBC]

To complete in consultation with Biosense – objectives and targets for auditing of hygiene protocols

11.0 Management Plan Review

The understanding of kauri dieback and protocols for managing and preventing the spread of it are continually evolving to reflect the latest research and scientific information available. The above therefore represents a detailed approach based on the most recently available data and information. However, it is expected that this will be amended and updated in accordance with current best practice to manage the spread of kauri dieback disease.

12.0 References

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Appendices

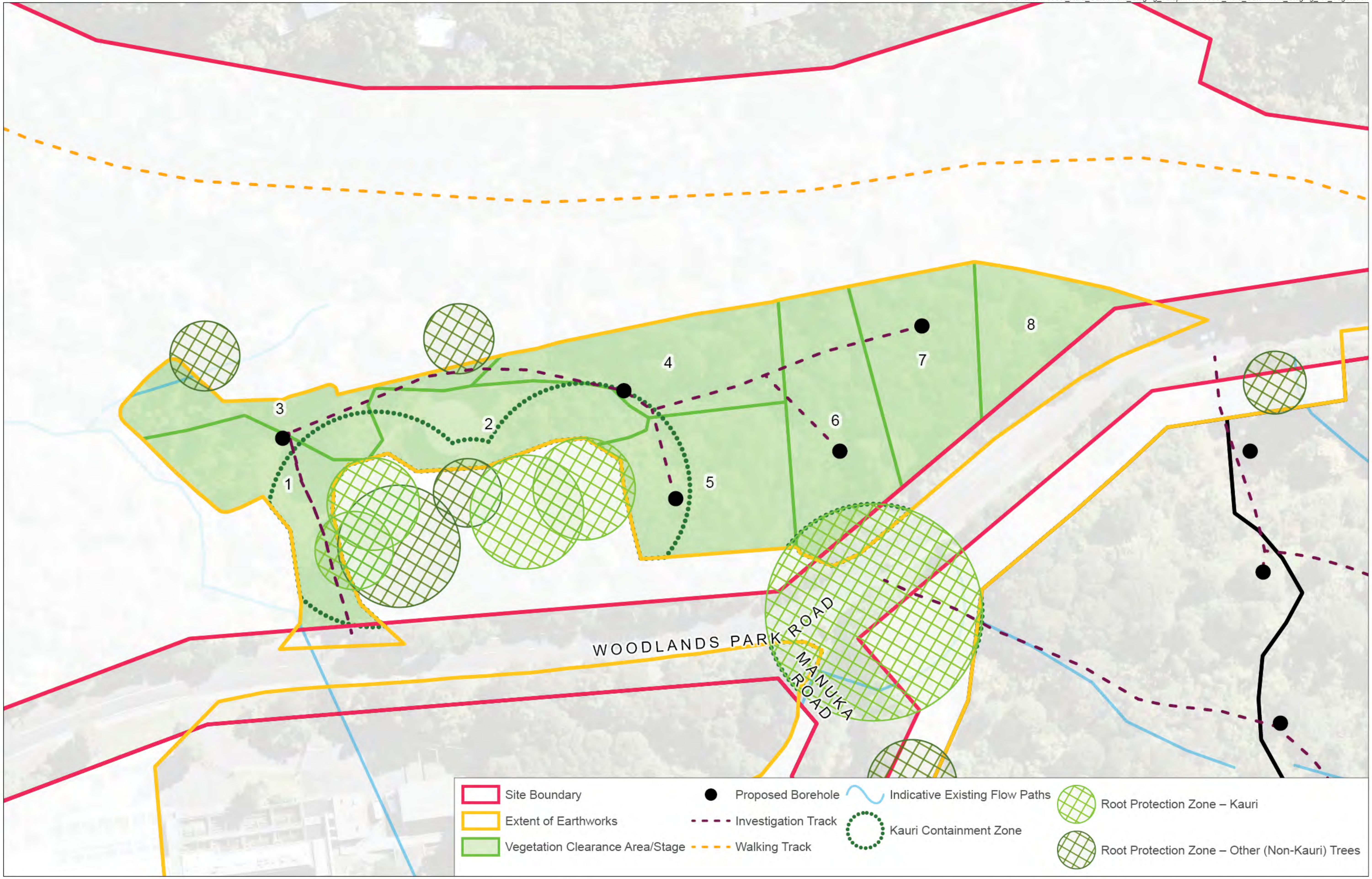
Appendix 1: GEOTECHNICAL INVESTIGATIONS AND VEGETATION CLEARANCE

As specified in Section 5.2.1 of the Kauri Dieback Management Plan, geotechnical assessments are required prior to design of the WTP. Localised vegetation clearance is required to enable geotechnical equipment access to test sites.

As specified in Section 5.2.2 of the Kauri Dieback Management Plan, site wide vegetation clearance will be carried out systematically to enable fauna checks to be undertaken, prior to commencement of earthworks.

The followingscheme plans detail the access routes for geotechnical investigations, and sequencing of subsequent site-wide vegetation clearance (using previously established access routes).

Explanatory notes for geotechnical investigations and vegetation clearance staging follow the staging plans.



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Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Geotech Investigations and Vegetation Clearance Staging – Reservoir 1

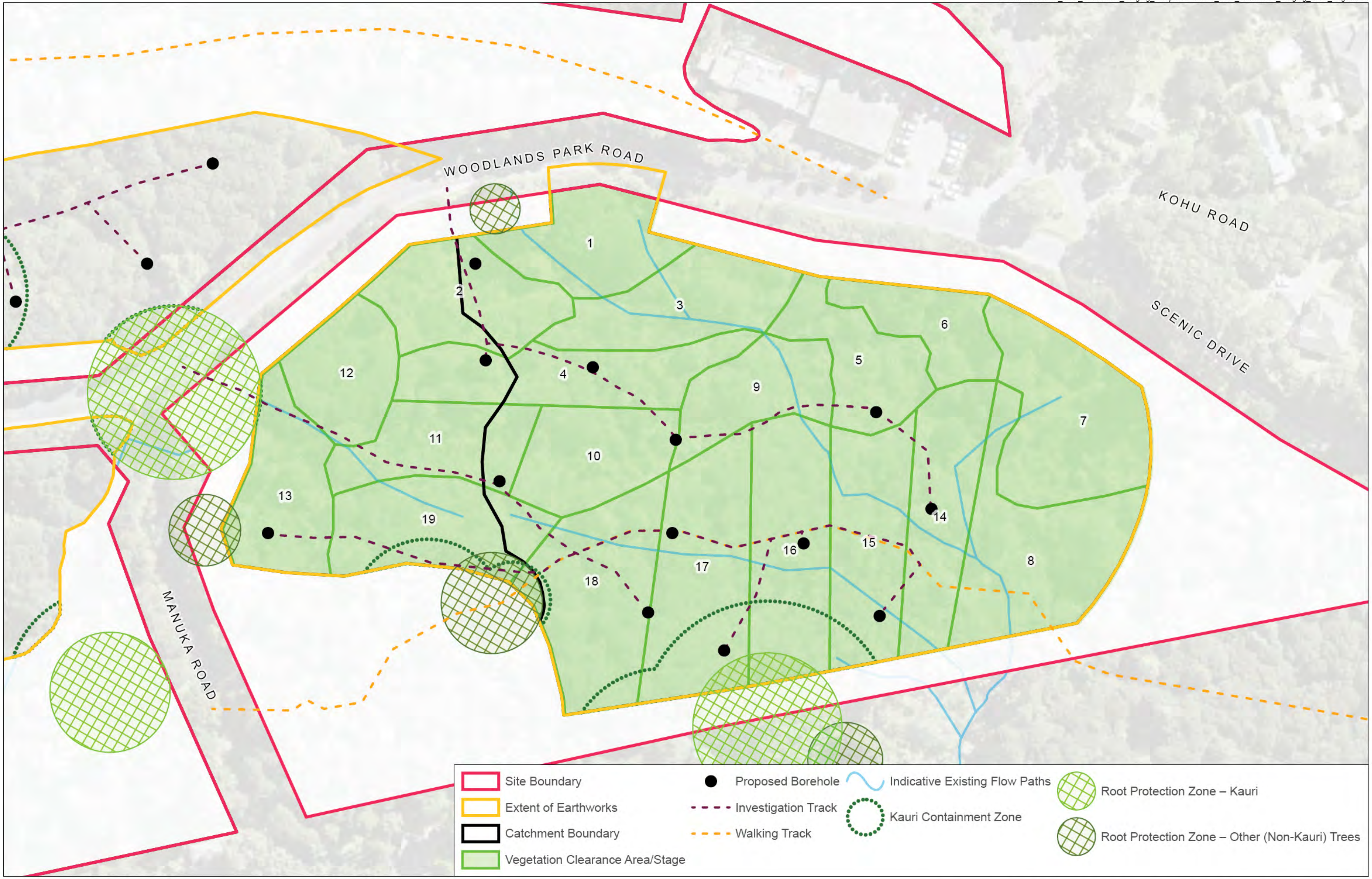
Date: 09 June 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Vegetation Clearance

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_Vegetation



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Geotech Investigations and Vegetation Clearance Staging – Water Treatment Plant

Date: 09 June 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Vegetation Clearance

Accompanying notes: GEOTECHNICAL INVESTIGATIONS

KEY STAGE OBJECTIVES\ CRITERIA

- Minimise disturbance areas to establish entrance controls for both sediment and Kauri Dieback containment.
- Provide sufficient clearance to allow access for geotechnical equipment and investigations.

KEY STAGE OPERATIONS

- Vegetation clearance required (prior to general vegetation clearance) to enable access for geotechnical equipment on site. Will generally involve clearance for a 4m wide access track and 8m diameter clearance at each drill spot for working space. Vegetation will be pushed to the side of clearance area (as opposed to being removed from site).
- Forming a stabilised entry and installing wash down facilities. Facility to include truck washdown facility with shaker ramp or approved equivalent to enable collection of all sediment and surface water from wash down process.

Accompanying notes: VEGETATION CLEARANCE

KEY STAGE OBJECTIVES\ CRITERIA

- Minimise accidental mortality of native fauna species
- Limit the extent of bare ground exposed at one time, reducing the potential for sediment runoff during rainfall events.

KEY STAGE OPERATIONS

- Vegetation clearance, including tree/scrub removal and grass/weedfield clearance will be carried out in stages across the construction footprint. This approach enables the appropriate management of effects
- The identified tree protection zones will require exploratory testing to confirm the exact extent of root zone to sufficiently protect the integrity of the tree. This information will be used to inform the design process.
- Vegetation clearance (including trees, scrub, grass and weedfield) is to be carried out in the appropriate season (as specified in the EMP).
- The works site will be progressively cleared in patches of approximately 0.1 – 0.2 ha (Figure1).

- Cleared areas are to be covered with mulched woody material/kanuka brush/geotextile cloth in the interim between vegetation clearance and topsoil removal.
- All native vegetation to be retained outside of the earthworks footprint must be protected through the construction process.
- Vegetation clearance must adhere to Kauri Dieback Management procedures with respect to hygiene and soil disturbance.
- Renew stabilised entry where necessary and clean out wash down facilities from geotechnical investigation phase. Facility to include truck washdown facility with shaker ramp or approved equivalent to enable collection of all sediment and surface water from wash down process.

STAGE ESTIMATED TIMEFRAME – Replacement WTP

- Stage estimated timeframe – 12 weeks
- Works estimated to commence Year 0 of programme.

STAGE ESTIMATED TIMEFRAME – Reservoir 1

- Stage estimated timeframe – 4 weeks
- Works estimated to commence Year 0 of programme.

Appendix 2: STAGED REMOVAL OF SURFACE SOIL LAYERS

As specified in Section 5.2.3 of the Kauri Dieback Management Plan, topsoil and any other potentially infected matter to a nominal depth of 0.5 m plus 0.5 m subsoil will be excavated in a staged manner and removed from site to minimise the risk of spreading Kauri Dieback disease during bulk earthworks. The staging process is planned by subcatchment within the Works footprint. This series of plans defines the subcatchment areas and details the staging sequence, kauri dieback containmentmeasures, and associated stormwater and sediment controls, as successive subcatchments within the Works Footprint are stripped and stabilised.

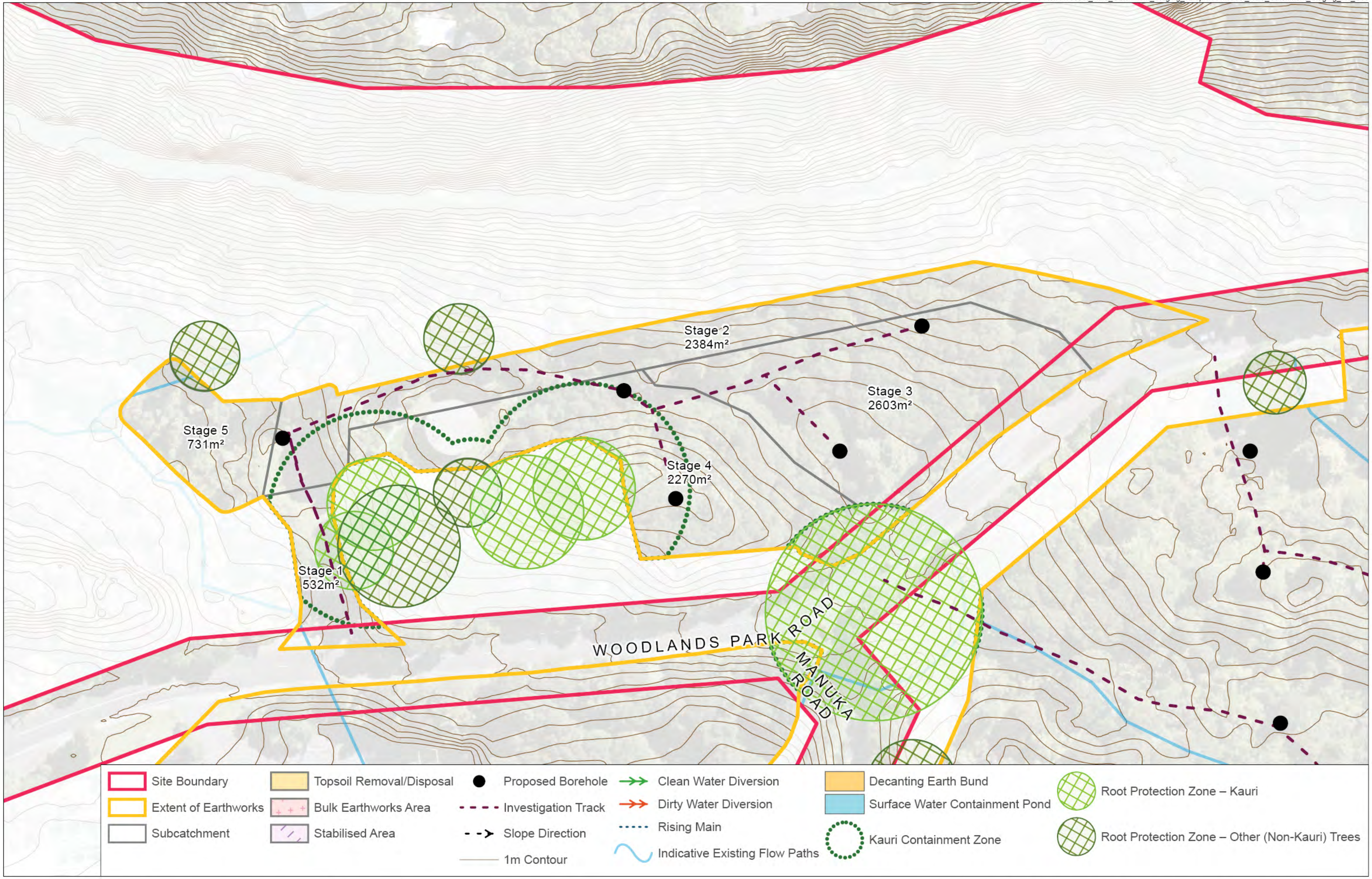
The staging plans for the proposed reservoir site are in the series “Topsoil removal disposal phase staging – Reservoir 1”. The staging plans for the proposed replacement water treatment site are in the series “Topsoil removal disposal phase staging – Water Treatment Plant”. No staging plans are provided for Reservoir 2 as the area of surface soil removal is sufficiently small that staging is not required.

Explanatory notes for each stage accompany the relevant plan.

RESERVOIR 1 SITE - STAGE 0

Overview showing subcatchment areas and boundaries, flow paths and access tracks.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_R1_S00



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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 0

RESERVOIR 1 SITE - STAGE 1

KEY STAGE OBJECTIVES\CRITERIA

- Minimise disturbance areas to establish entrance controls for both sediment and Kauri Dieback containment.
- Assumed all site offices and laydown areas will be situated on the HRWTP site during this stage of operations.
- All controls to be sized based on criteria setout for the HRWTP site.
  - Maximum topsoil disposal area 3000m²
  - DEB to treat surface water runoff to remove sediment load.
  - Surface water containment pond (established Stage 3) to be sized to contain the full 10-year rainfall event from the 3000m² catchment.

KEY STAGE OPERATIONS

- Renew stabilised entry where necessary and clean out wash down facilities from vegetation clearance phase. Facility to include truck washdown facility with shaker ramp or approved equivalent to enable collection of all sediment and surface water from wash down process.
- The water collected from the washdown process during the topsoil disposal and prior phases will be collected and transported offsite.
- Progressively remove topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and expand stabilised area within the stage 1 area.
- All works to be done with localised sediment controls and works area stabilised at completion of each work day.
- All downstream vegetation clearance measures to remain in place.

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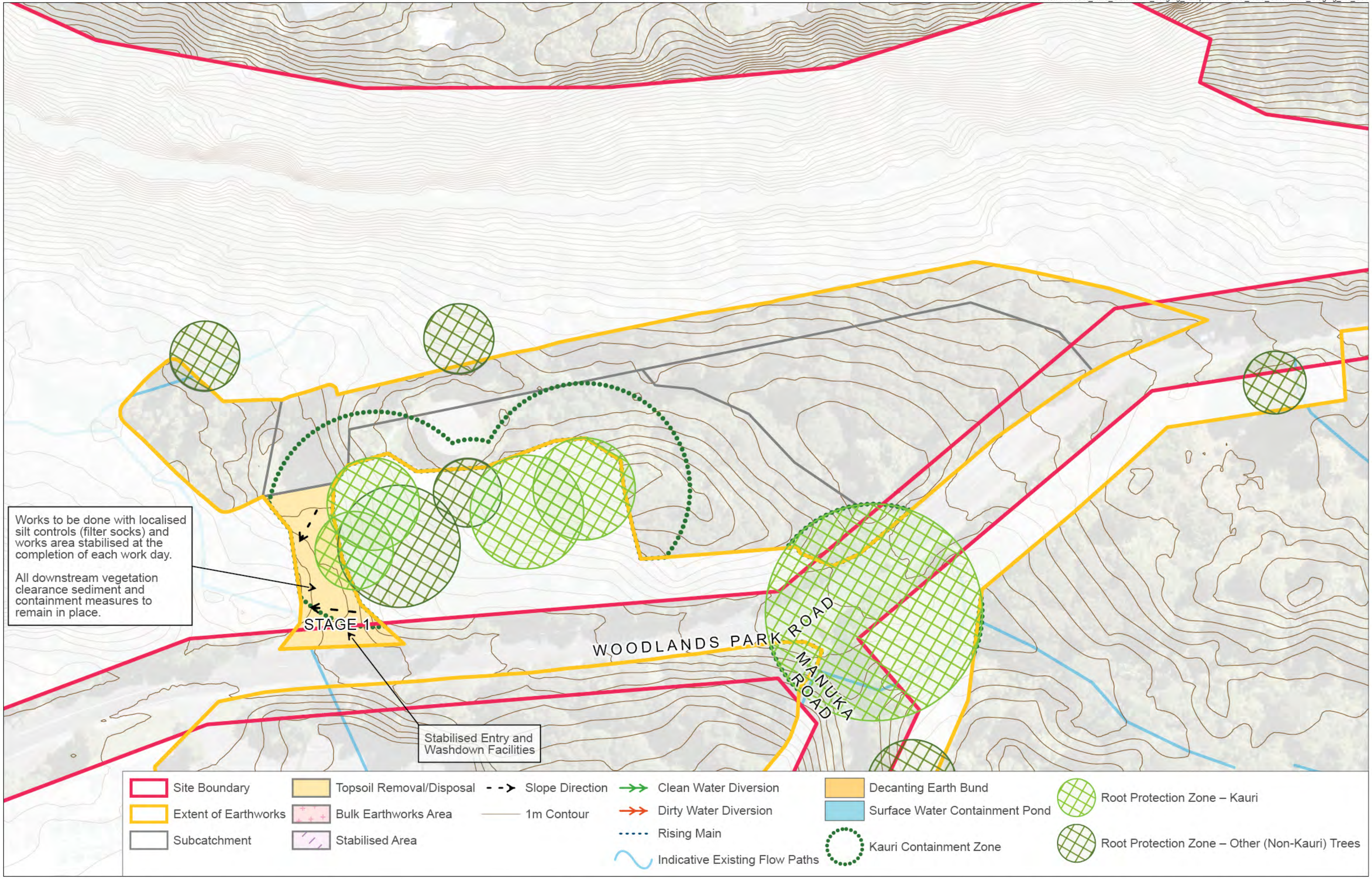

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 1

RESERVOIR 1 SITE - STAGE 2

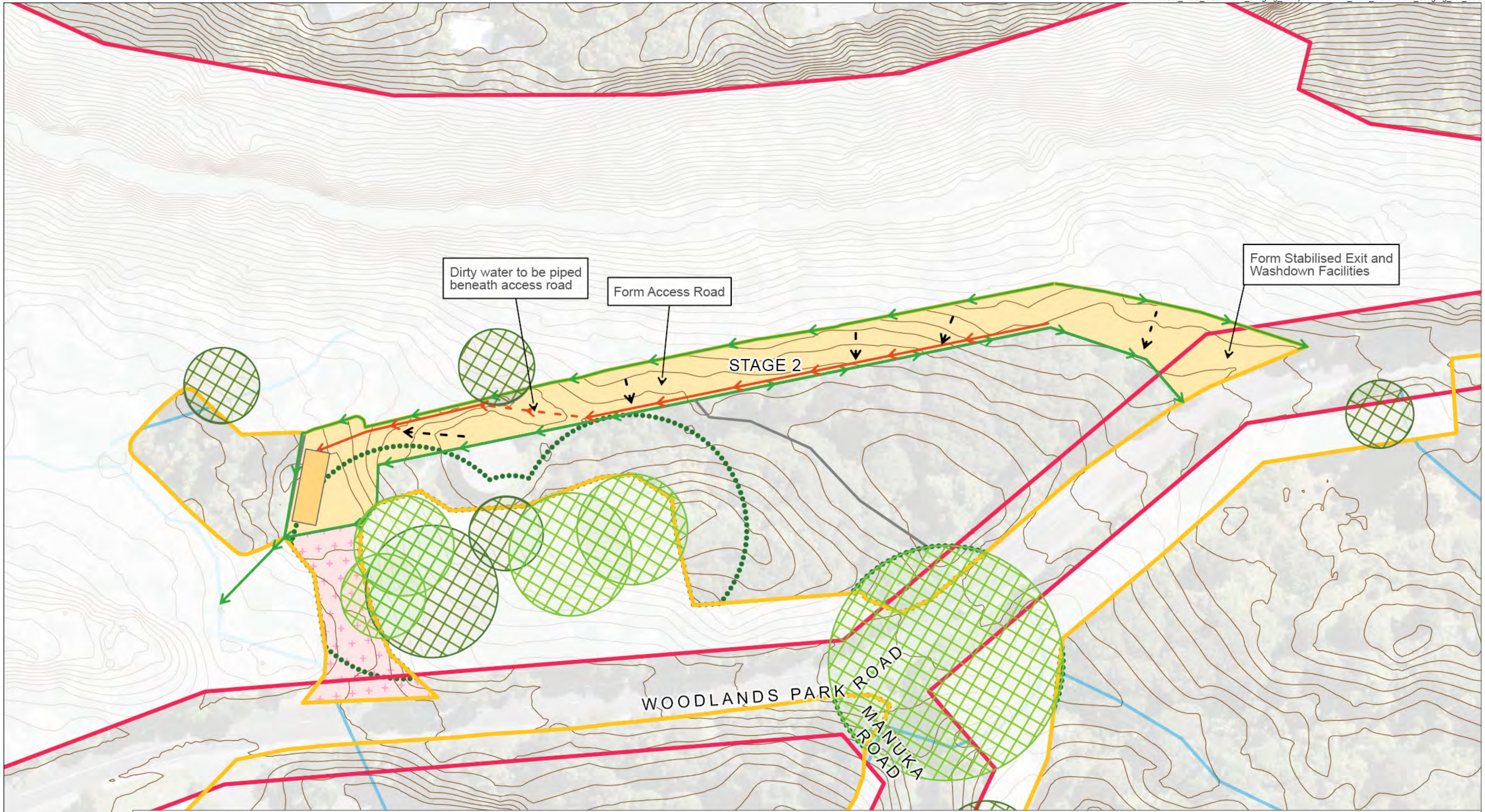
KEY STAGE OBJECTIVES\CRITERIA

- Establish access road along northern boundary of disturbance area and secondary access point (exit only).

KEY STAGE OPERATIONS

- Establish decanting earth bund
- Establish cleanwater diversion upslope of disturbance area.
- Construct dirty water channel downslope of disturbance area and convey flows to decanting earth bund.
- Progressively remove topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and dispose of off-site. Expand stabilised area within the stage 2 area.
- Works within kauri containment zone (KCZ) to be progressively excavated and hardfill hardstand extending into KCZ as works progress.
- All downstream vegetation clearance measures to remain in place.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_R1_S02



Site Boundary
Extent of Earthworks
Subcatchment
Topsoil Removal/Disposal
Bulk Earthworks Area
Stabilised Area
Slope Direction
1m Contour
Clean Water Diversion
Dirty Water Diversion
Dirty Water Diversion (Piped)
Rising Main
Indicative Existing Flow Paths
Decanting Earth Bund
Surface Water Containment Pond
Kauri Containment Zone
Root Protection Zone – Kauri
Root Protection Zone – Other (Non-Kauri) Trees

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 2

RESERVOIR 1 SITE - STAGE 3

KEY STAGE OBJECTIVES\CRITERIA

- Establish surface water containment pond and rising main for discharge.
- Complete any bulk earthworks within Stage 2 corridor.

KEY STAGE OPERATIONS

- Establish decanting earth bund for stage catchment
- Establish cleanwater diversion upslope of disturbance area.
- Construct dirty water channel downslope of disturbance area and convey flows to decanting earth bund.
- Progressively remove topsoil to and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and dispose of off-site. Expand stabilised area within the stage 3 area.
- Works within kauri containment zone (KCZ) to be progressively excavated and hardfill hardstand extending into KCZ as works progress.

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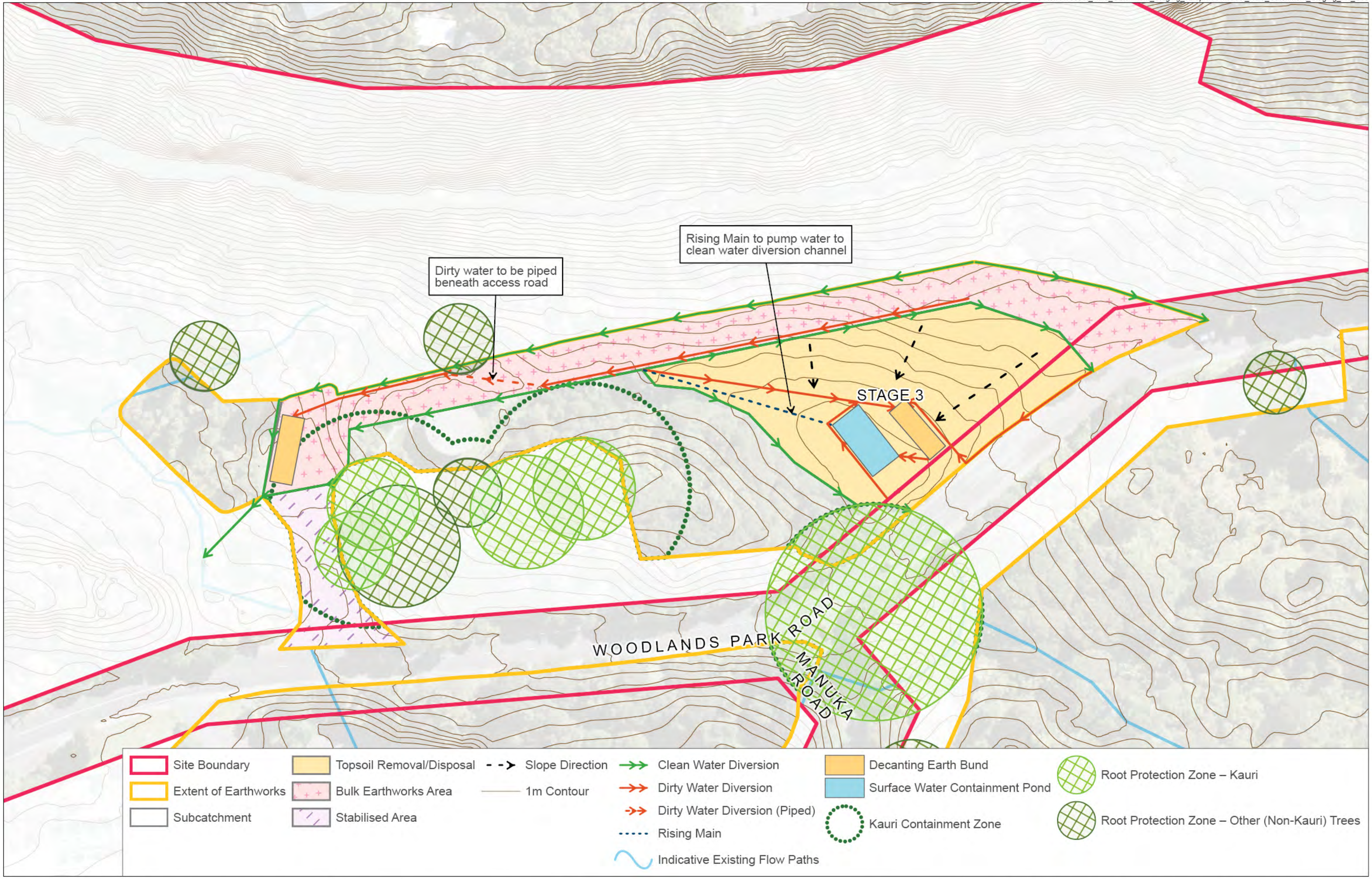

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 3

RESERVOIR 1 SITE - STAGE 4

KEY STAGE OBJECTIVES\CRITERIA

- Complete topsoil removal phase from reservoir footprint.
- Continue with bulk earthworks within Stage 3

KEY STAGE OPERATIONS

- Establish decanting earth bund for stage catchment
- Establish cleanwater diversion upslope of disturbance area.
- Construct dirty water channel downslope of disturbance area and convey flows to decanting earth bund.
- Progressively remove topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and dispose of off-site. Expand stabilised area within the stage 4 area.
- Works within kauri containment zone (KCZ) to be progressively excavated and hardfill hardstand extending into KCZ as works progress.

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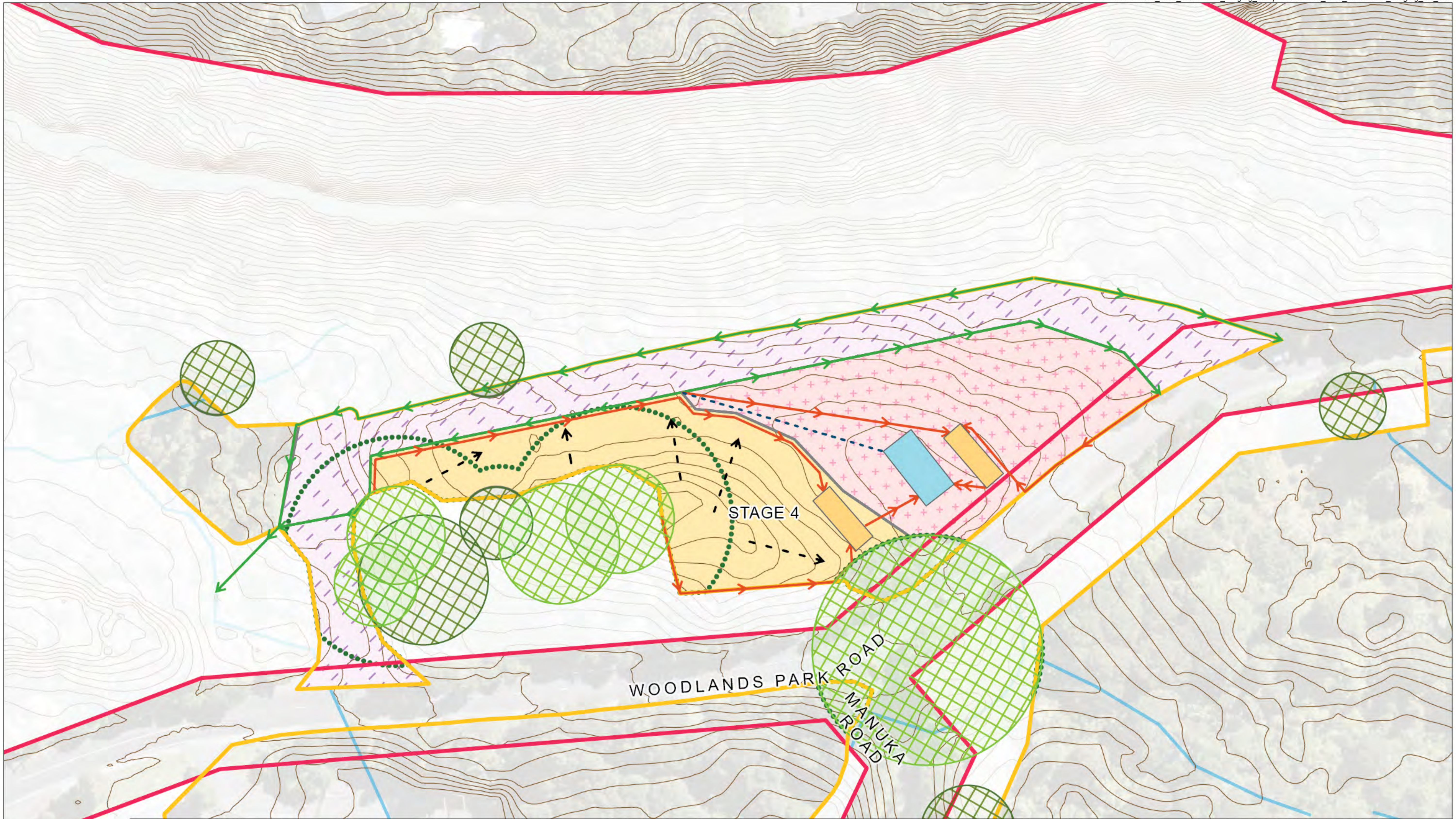

- Site Boundary
- Extent of Earthworks
- Subcatchment
- Topsoil Removal/Disposal
- Bulk Earthworks Area
- Stabilised Area
- Slope Direction
- 1m Contour
- Clean Water Diversion
- Dirty Water Diversion
- Rising Main
- Indicative Existing Flow Paths
- Decanting Earth Bund
- Surface Water Containment Pond
- Kauri Containment Zone
- Root Protection Zone – Kauri
- Root Protection Zone – Other (Non-Kauri) Trees

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 4

RESERVOIR 1 SITE - STAGE 5

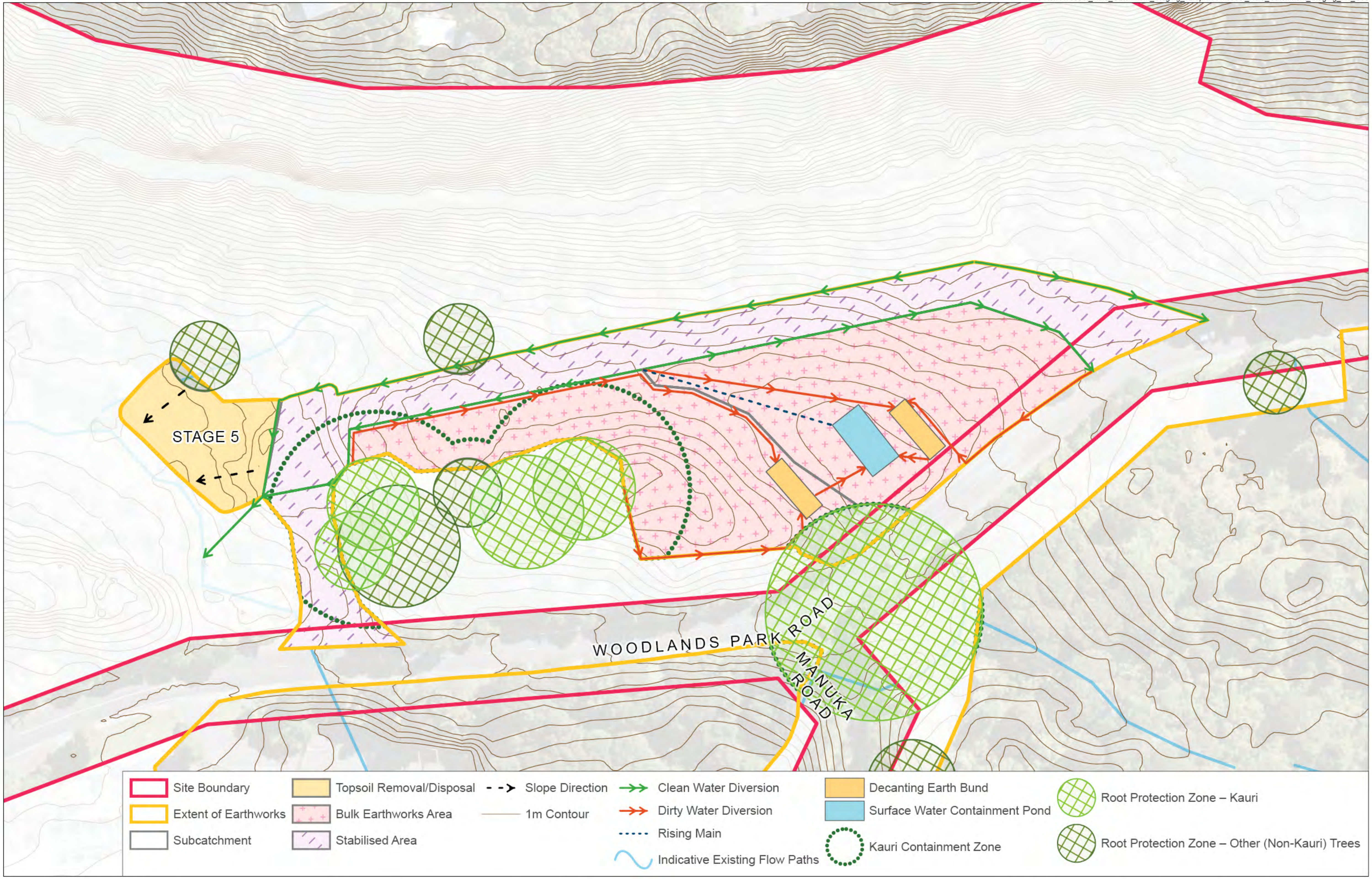
KEY STAGE OBJECTIVES\CRITERIA

- Complete topsoil removal phase from Reservoir 1 site (NH2 tunnel).
- Continue with bulk earthworks within Stages 3&4

KEY STAGE OPERATIONS

- Progressively remove topsoil and expand stabilised area within the stage 5 area.
- All works to be done with localised sediment controls and works area stabilised at completion of each work day.
- The water collected from the washdown process (during the topsoil disposal and prior phases) will be collected and transported offsite.
- Once the site is "clean" i.e. topsoil disposal phase is completed, water would be treated to remove sediment load and then discharged downstream.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_R1_S05



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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Reservoir 1

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

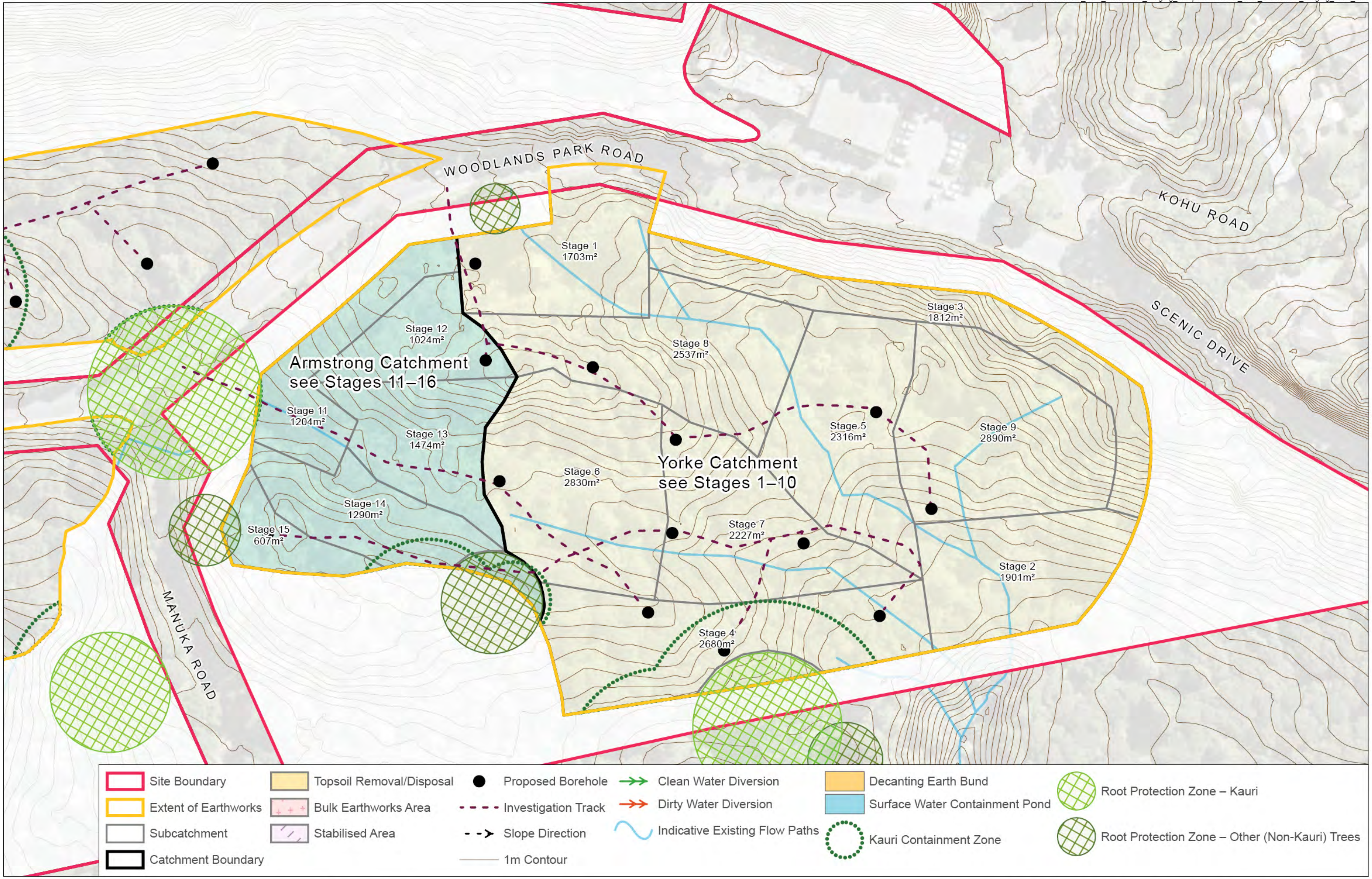
Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 5

WATER TREATMENT PLANT SITE - STAGE 0

Overview of subcatchment areas and boundaries, flow paths and access tracks

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S00



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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 0

WATER TREATMENT PLANT SITE - STAGE 1

KEY STAGE OBJECTIVES\CRITERIA

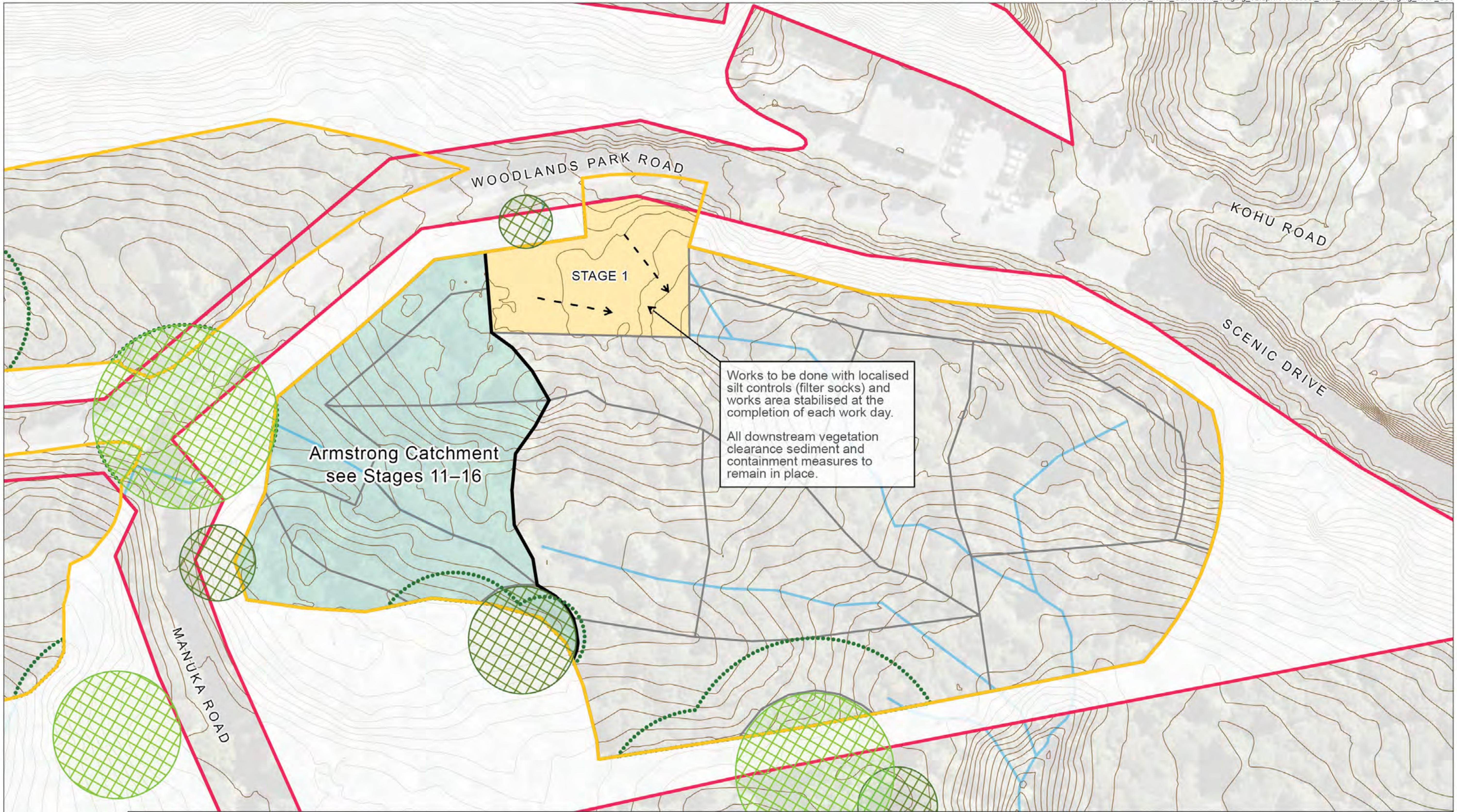
- Minimise disturbance areas to establish entrance controls for both sediment and Kauri Dieback containment.

KEY STAGE OPERATIONS

- Renew stabilised entry where necessary and clean out wash down facilities from vegetation clearance phase. Facility to include truck washdown facility with shaker ramp or approved equivalent to enable collection of all sediment and surface water from wash down process.
- The water collected from the washdown process (during the topsoil disposal and prior phases) will be collected and transported offsite.
- Progressively remove topsoil and expand stabilised area to create a laydown area for plant and site offices within the stage 1 area. Top soil to be loaded directly onto trucks, covered and then transported for offsite disposal.
- All works to be done with localised sediment controls and works area stabilised at completion of each work day.
- All works to be completed in accordance with Site Management Plan (SMP) procedures to manage potentially contaminated material.
- All downstream vegetation clearance measures to remain in place.

EARTHWORKS VOLUMES

- Topsoil removal 850m^3
  - Cut 1100m^3
  - Fill 200m^3
- Stage estimated timeframe - 4-6 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 1 of programme.



Site Boundary
Extent of Earthworks
Subcatchment
Catchment Boundary
Topsoil Removal/Disposal
Bulk Earthworks Area
Stabilised Area
Slope Direction
1m Contour
Clean Water Diversion
Dirty Water Diversion
Indicative Existing Flow Paths
Decanting Earth Bund
Surface Water Containment Pond
Kauri Containment Zone
Root Protection Zone – Kauri
Root Protection Zone – Other (Non-Kauri) Trees

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 03 December 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 1

WATER TREATMENT PLANT SITE - STAGE 2

KEY STAGE OBJECTIVES\CRITERIA

- Establish sediment pond (surface water containment pond) which shall be used only for stormwater containment during topsoil removal phase (stage 4 onwards). All ponds shall be sized to contain at least the full 10 year storm event from the maximum proposed work area. The works area shall not exceed $3000m^2$.
- All future work stages will utilise a two stage treatment process. At source treatment for sediment shall be provided for each catchment with a decanting earth bund (deb). Decanting earth bunds shall be sized based on 3% of the catchment area (as opposed to 2% (GD05)). Water shall then be discharge to SRP S1 for containment/treatment prior to discharge to receiving environment.
- No topsoil removal/disposal catchment will exceed an area of $3000m^2$.

KEY STAGE OPERATIONS

- Utilising existing access tracks and extend as necessary to allow for formation of SRP S1 (surface water containment pond).
- Construct cleanwater diversion upstream of pond site.
- Construct SRP S1
- Excavate topsoil and any other potentially infected matter to a nominal depth of 0.5 m plus 0.5 m subsoil[2], and remove from site.

EARTHWORKS VOLUMES

- Topsoil removal $950m^3$
    - CUT $0m^3$
    - FILL $3800m^3$*

      *Earthworks volume likely to completed later in programme following completion of retaining structure.
- Stage estimated timeframe - 3-4 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 3 of programme.

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[2] In all instances the actual depth will vary across the site. The Project Arborist is to supervise works and advise the necessary depth required for removal.

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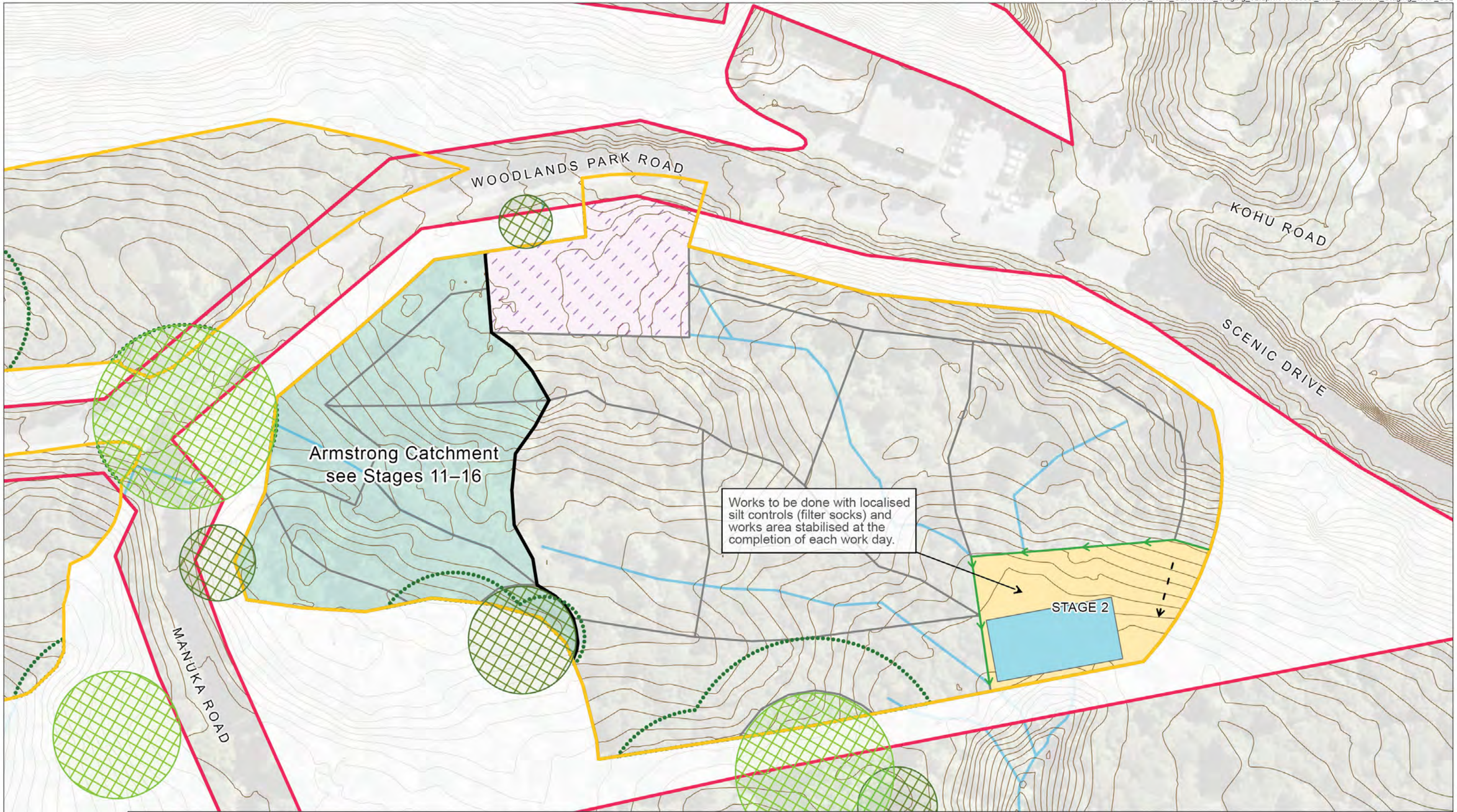

- Site Boundary
- Extent of Earthworks
- Subcatchment
- Catchment Boundary
- Topsoil Removal/Disposal
- Bulk Earthworks Area
- Stabilised Area
- Slope Direction
- 1m Contour
- Clean Water Diversion
- Dirty Water Diversion
- Indicative Existing Flow Paths
- Decanting Earth Bund
- Surface Water Containment Pond
- Kauri Containment Zone
- Root Protection Zone – Kauri
- Root Protection Zone – Other (Non-Kauri) Trees

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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 03 December 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 2

WATER TREATMENT PLANT SITE - STAGE 3

KEY STAGE OBJECTIVES\CRITERIA

- Divert external catchment surface flows away from the works area.
- Allow for establishment of permanent intermittent stream realignment.

KEY STAGE OPERATIONS

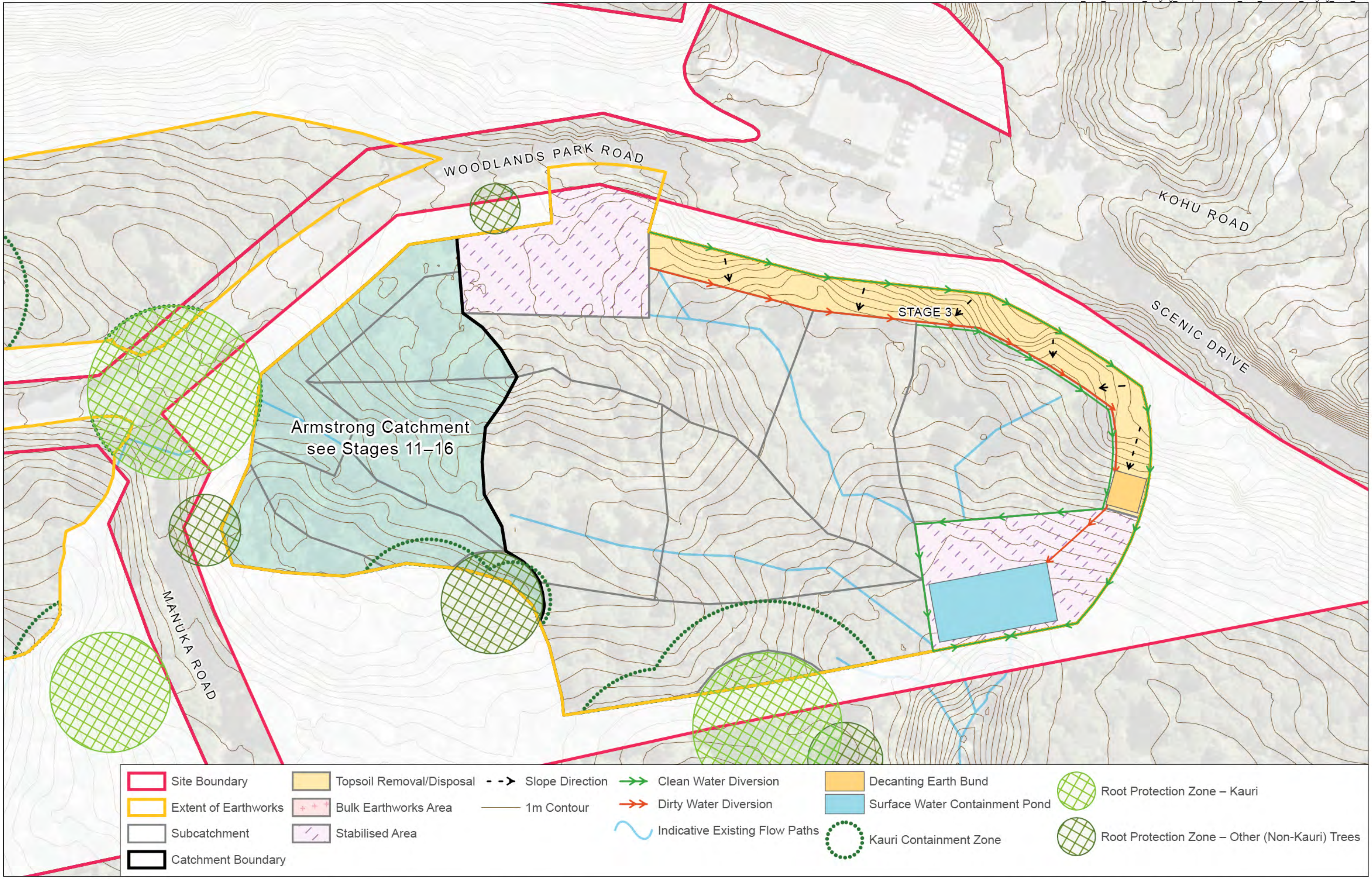
- Establish cleanwater diversion upslope of disturbance area.
- Construct dirty water channel downslope of disturbance area and convey flows to SRP S1.
- Works to progress south to north with cutoff drains in place at northern border of exposed works area to ensure clean water is diverted away.
- All works to be completed in accordance with Site Management Plan (SMP) procedures to manage potentially contaminated material.
- Excavate topsoil and any other potentially contaminated material and infected matter to a nominal depth of 0.5 m plus 0.5 m subsoil[1].
- Top soil and any contaminated material to be loaded directly onto trucks, covered and then transported for offsite disposal.

EARTHWORKS VOLUMES

- Topsoil removal 900m^3
    - CUT 1200m^3*
    - FILL 1500m^3*

  *Earthworks include estimated allowance for construction of pond.

- Stage estimated timeframe - 4-6 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 6 of programme.



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A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 3

WATER TREATMENT PLANT SITE - STAGE 4

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate potential spread of Kauri Dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

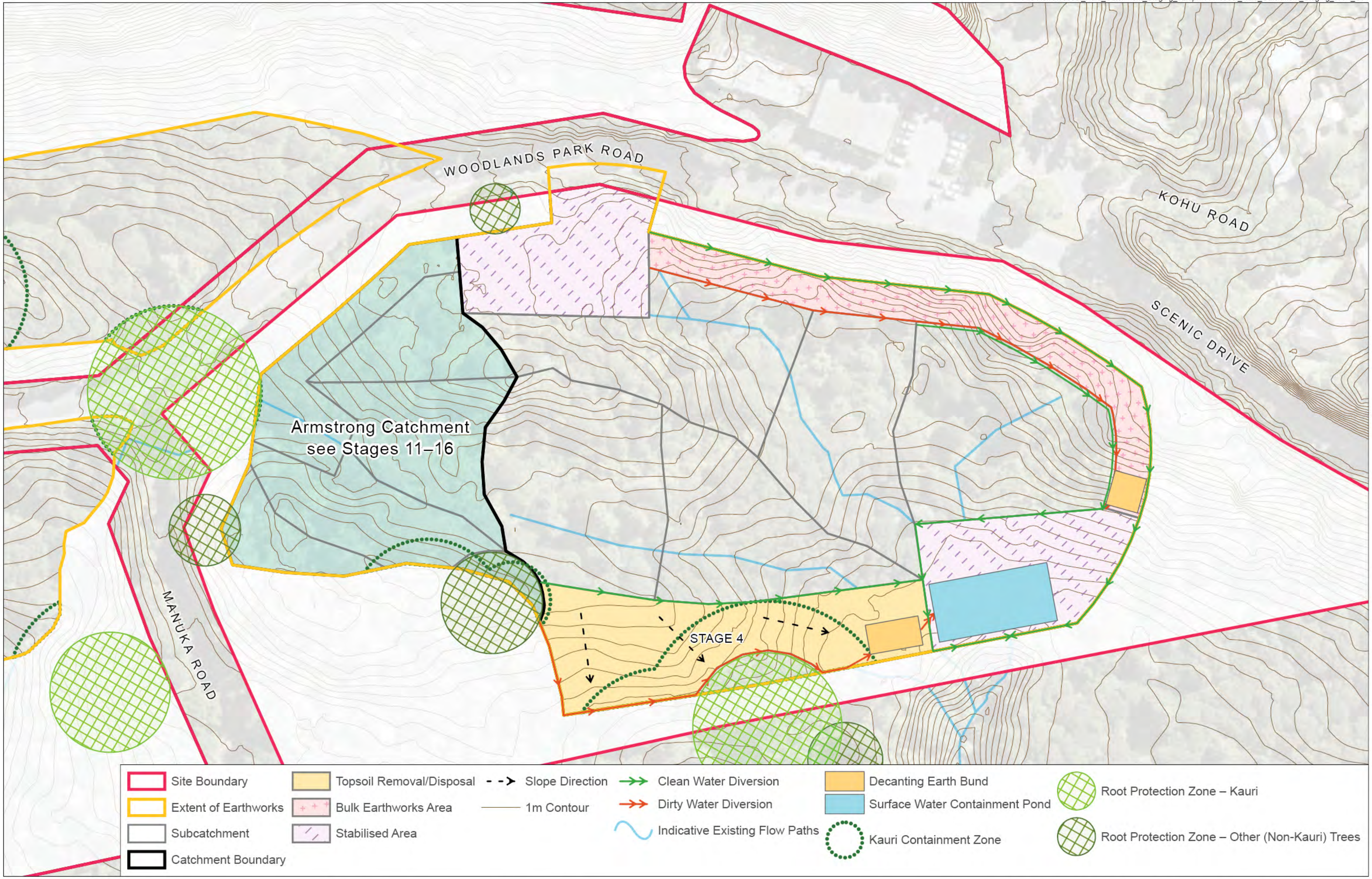
KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund.
- Establish localised washdown area. All washdown water to discharge to decanting earth bund or to separate containment facility.
- Works within kauri containment zone (KCZ) to be progressively excavated north to south with hardfill hardstand extending into KCZ.
- Following completion of KCZ works construct dirty water conveyance channel along the southern boundary discharging to DEB.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1].
- Top soil and any infected material to be loaded directly onto trucks, covered and then transported for offsite disposal and remove from site.

EARTHWORKS VOLUMES

- Topsoil removal 1350m³
    - Cut 4300m³
    - Fill 8000m³
- Stage estimated timeframe - 20- 24 weeks (includes 4 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 10 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S04



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 4

WATER TREATMENT PLANT SITE - STAGE 5

KEY STAGE OBJECTIVES\CRITERIA

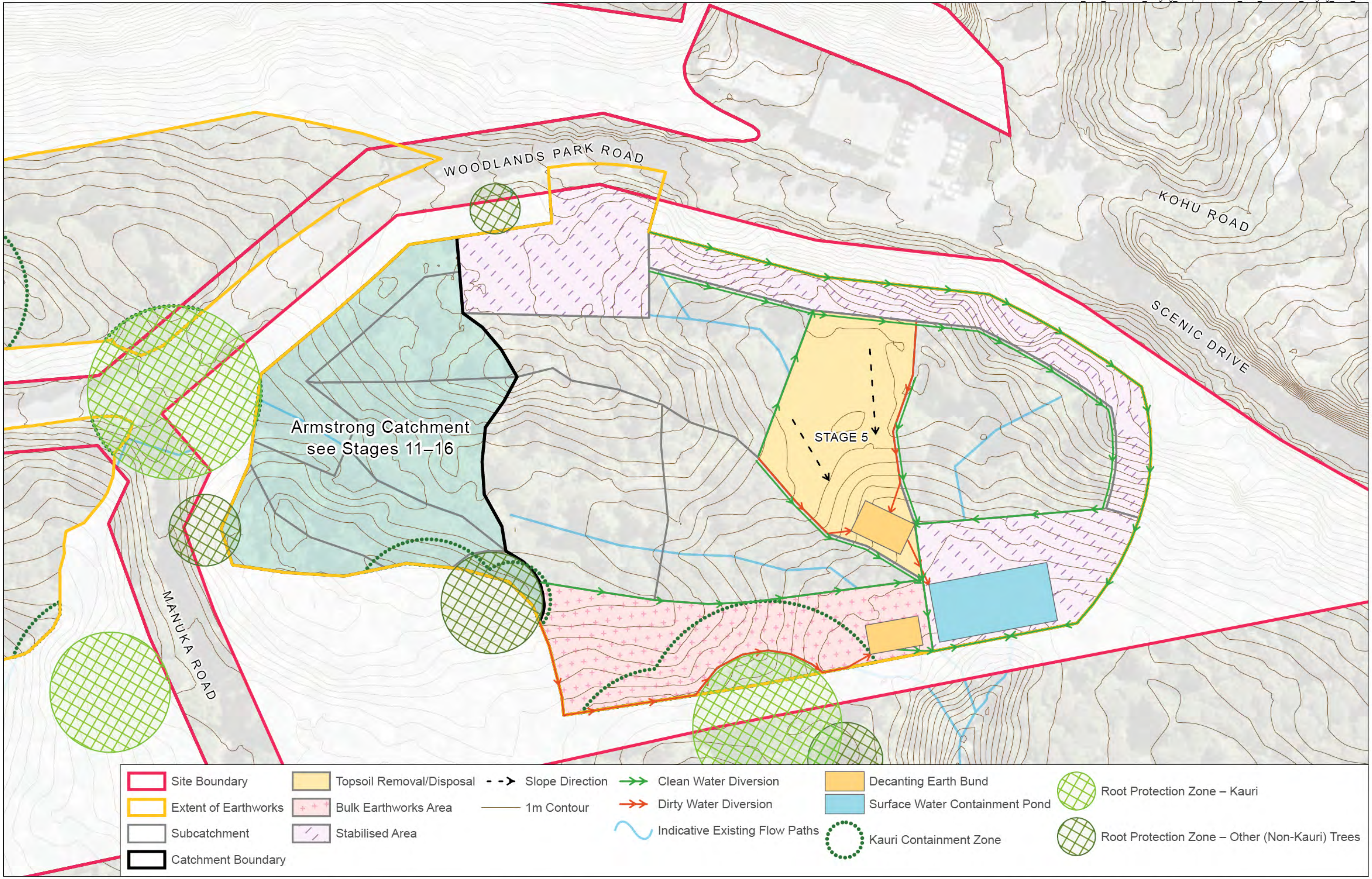
- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate spread of Kauri Dieback.
- previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area. Connect/pipe to existing clean water diversion (CWD) to the north.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil removal 1160m^3
  - Cut 3600m^3
  - Fill 4500m^3
- Stage estimated timeframe - 18 - 22 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 14 of programme.



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 5

WATER TREATMENT PLANT SITE - STAGE 6

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate spread of Kauri Dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

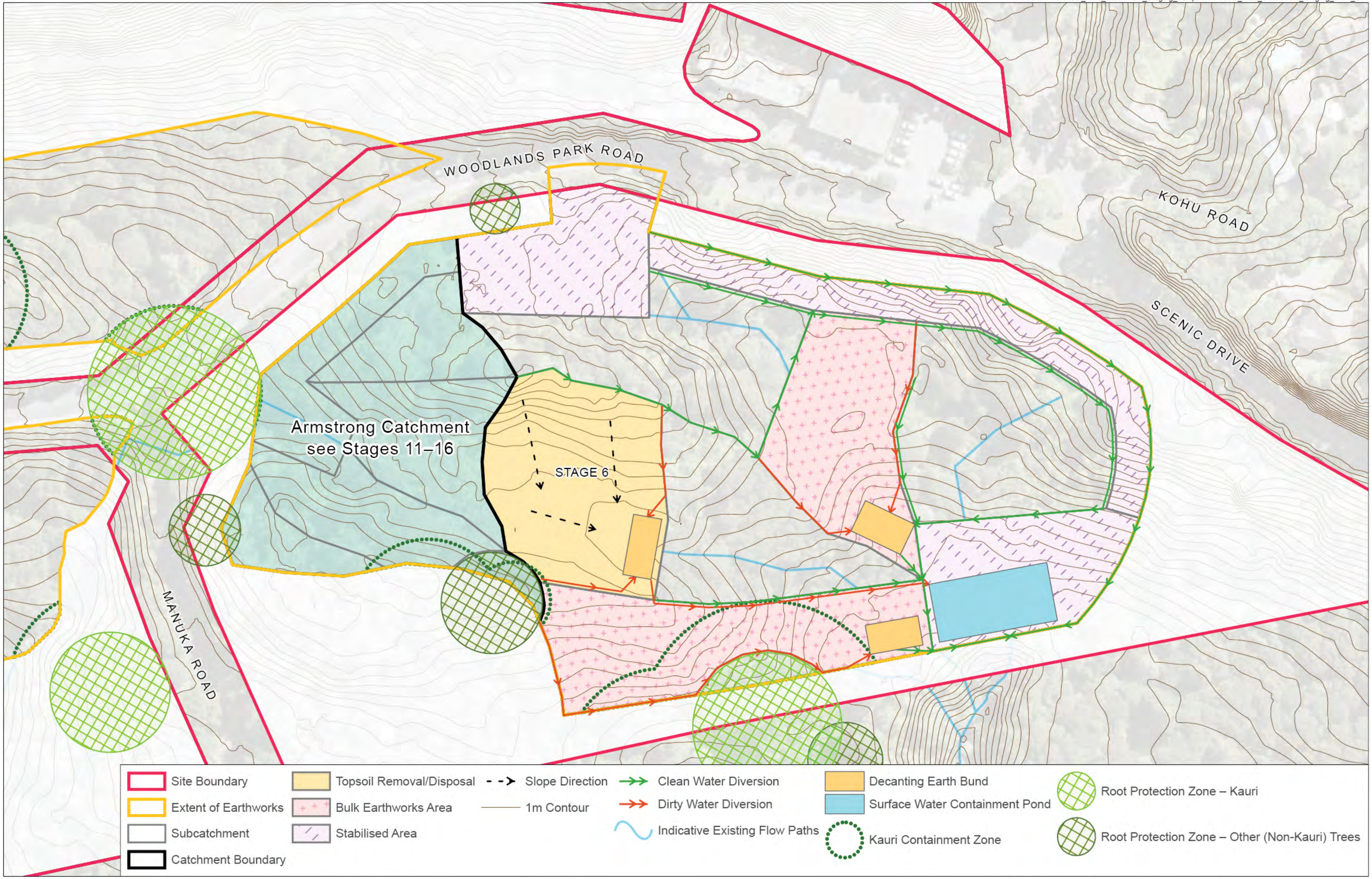
KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area. Connect/pipe to existing CWD to the north.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil removal 1420m³
    - Cut 10,400m³
    - Fill 900m³
- Stage estimated timeframe - 30-36 weeks (includes 3 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 16 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S06



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 6

WATER TREATMENT PLANT SITE - STAGE 7

KEY STAGE OBJECTIVES\CRITERIA

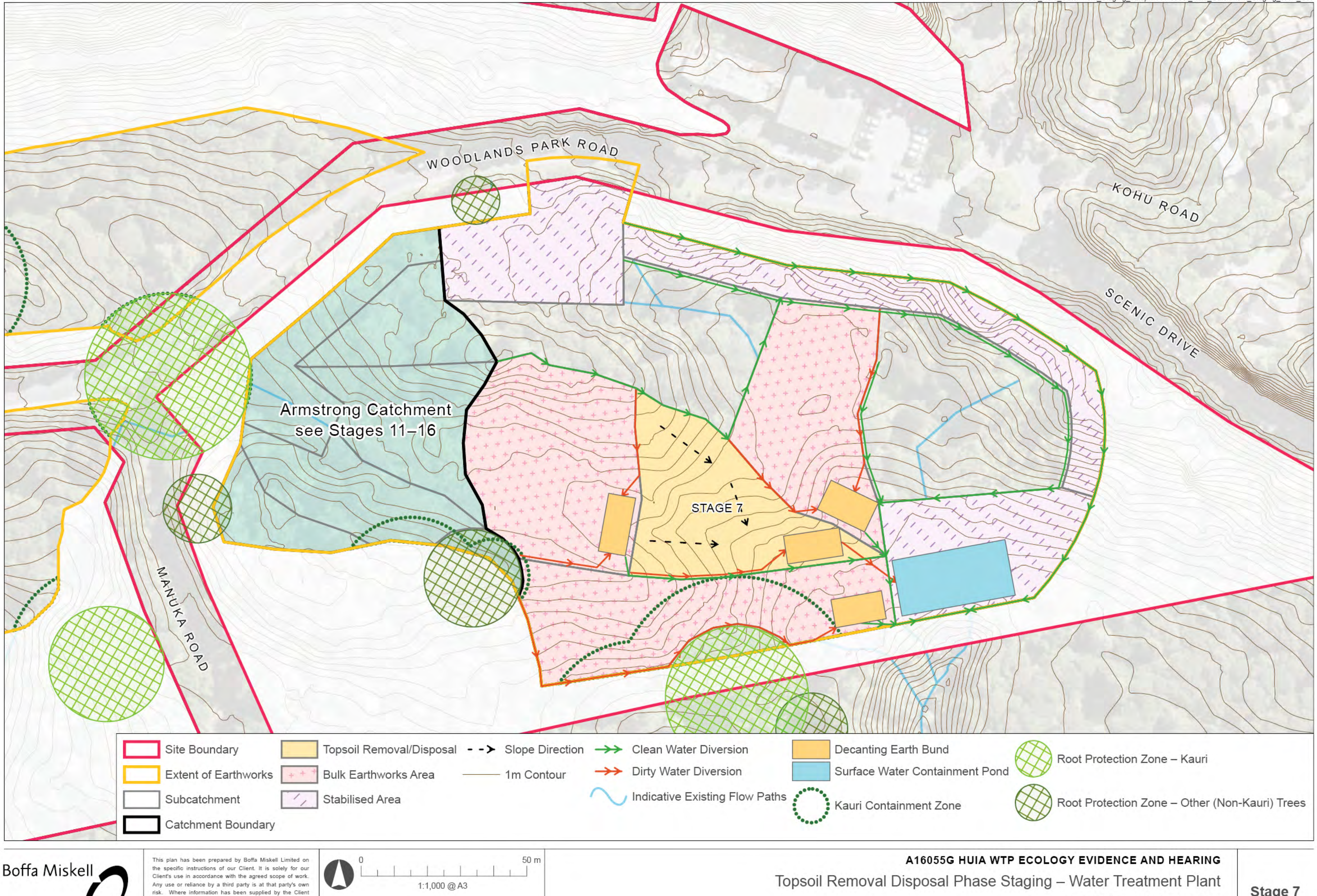
- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate spread of Kauri Dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area. Connect/pipe to existing CWD to the north.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil removal 1120m^3
    - Cut 7000m^3
    - Fill 5000m^3
- Stage estimated timeframe - 28- 34 weeks (includes 2 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 19 of programme.



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 7

WATER TREATMENT PLANT SITE - STAGE 8

KEY STAGE OBJECTIVES\CRITERIA

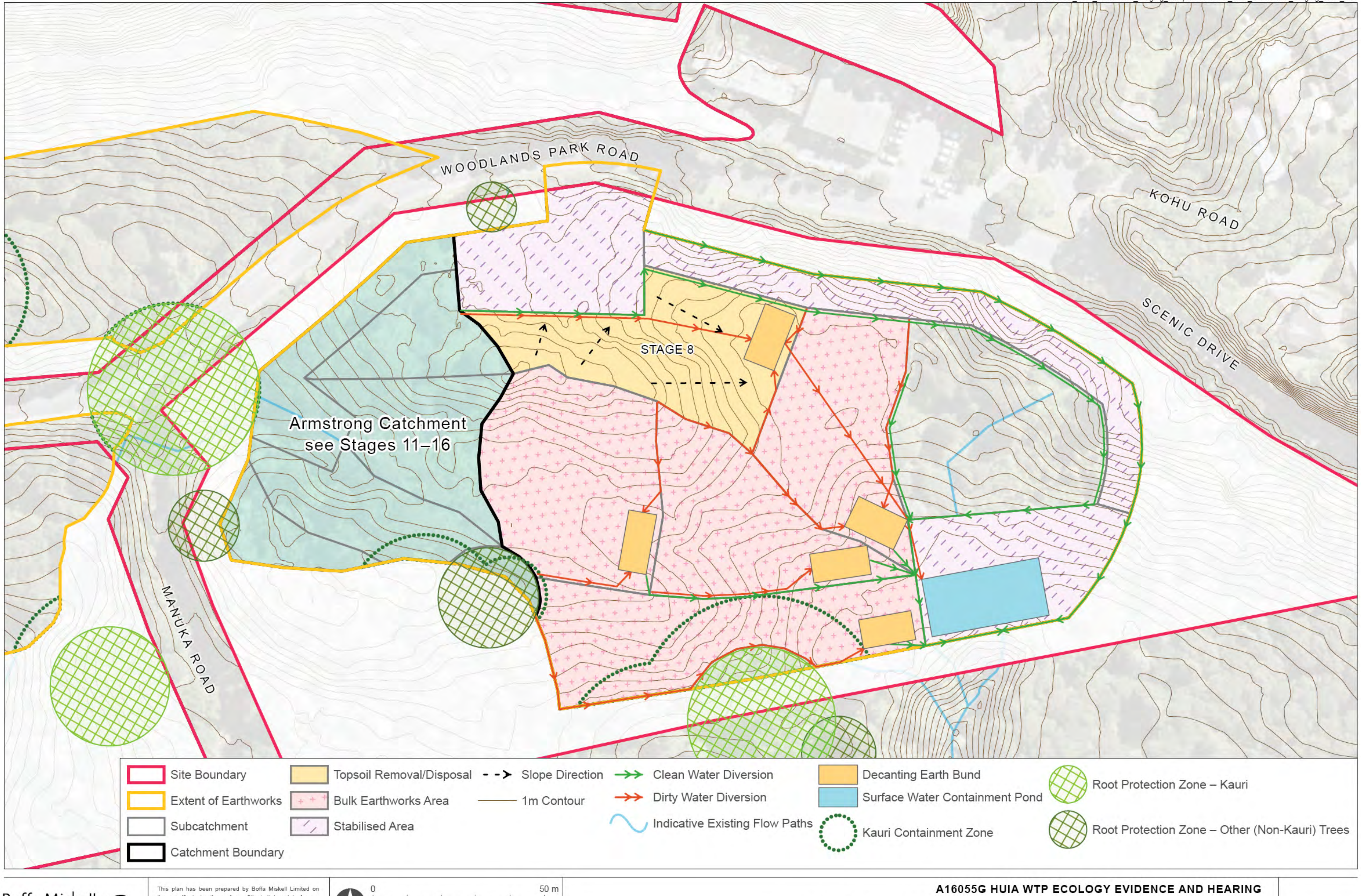
- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate spread of Kauri Dieback.
- All works to be completed in accordance with Site Management Plan (SMP) procedures to manage potentially contaminated material.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially contaminated material and infected matter and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil removal 1270m^3
  - Cut 6500m^3
  - Fill 3800m^3
- Stage estimated timeframe - 19-22 weeks (includes 2 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 21 of programme.



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 8

WATER TREATMENT PLANT SITE - STAGE 9

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S1 provides surface run off containment to mitigate spread of Kauri Dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

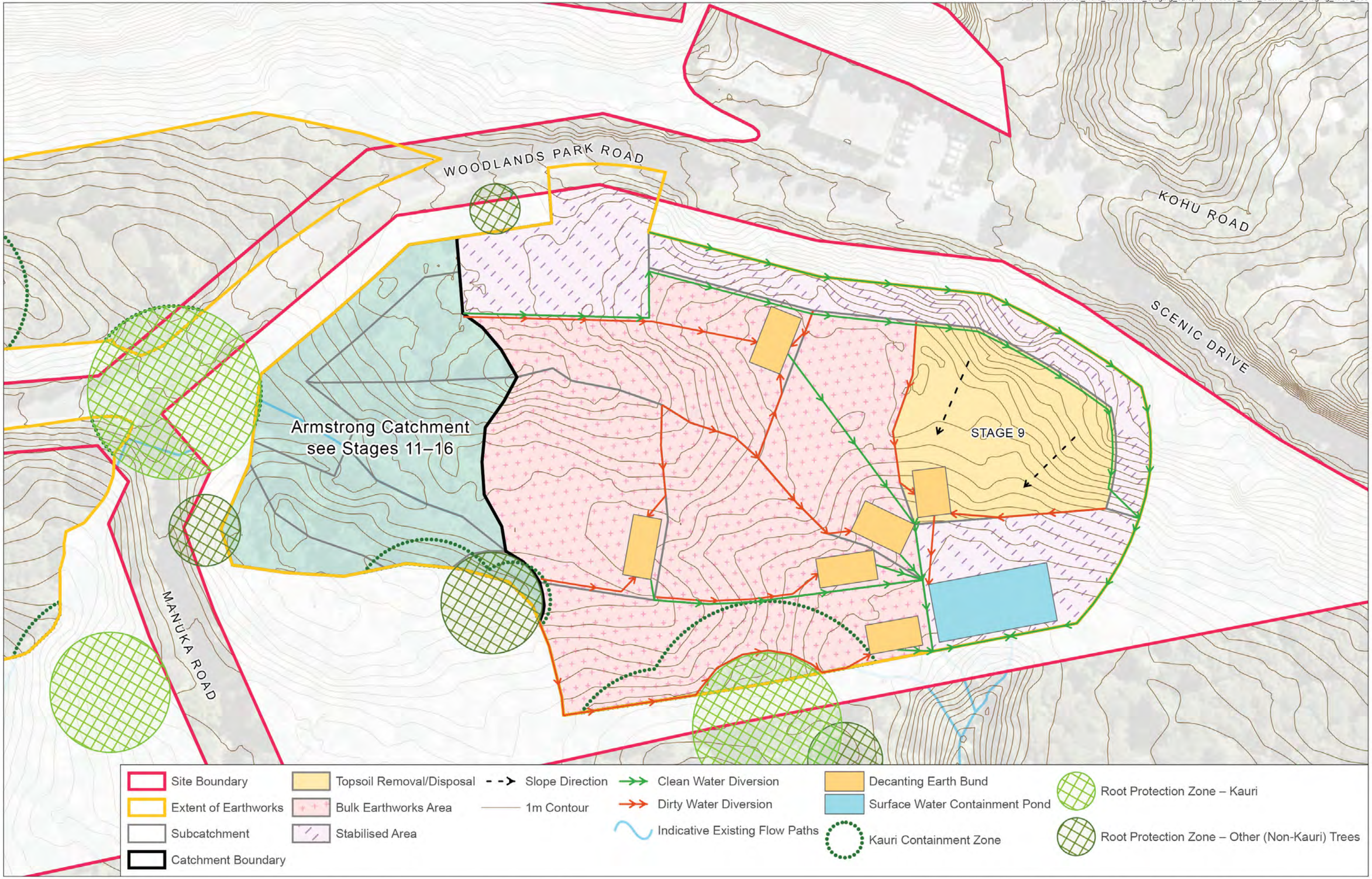
EARTHWORKS VOLUMES

- Topsoil removal 1450m^3
    - Cut 2700m^3*
    - Fill 500m^3*

*Bulk earthworks volumes exclude volume required to create laydown area.

- Stage estimated timeframe - 6-9 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 23 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S09



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 03 December 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 9

WATER TREATMENT PLANT SITE - STAGE 10

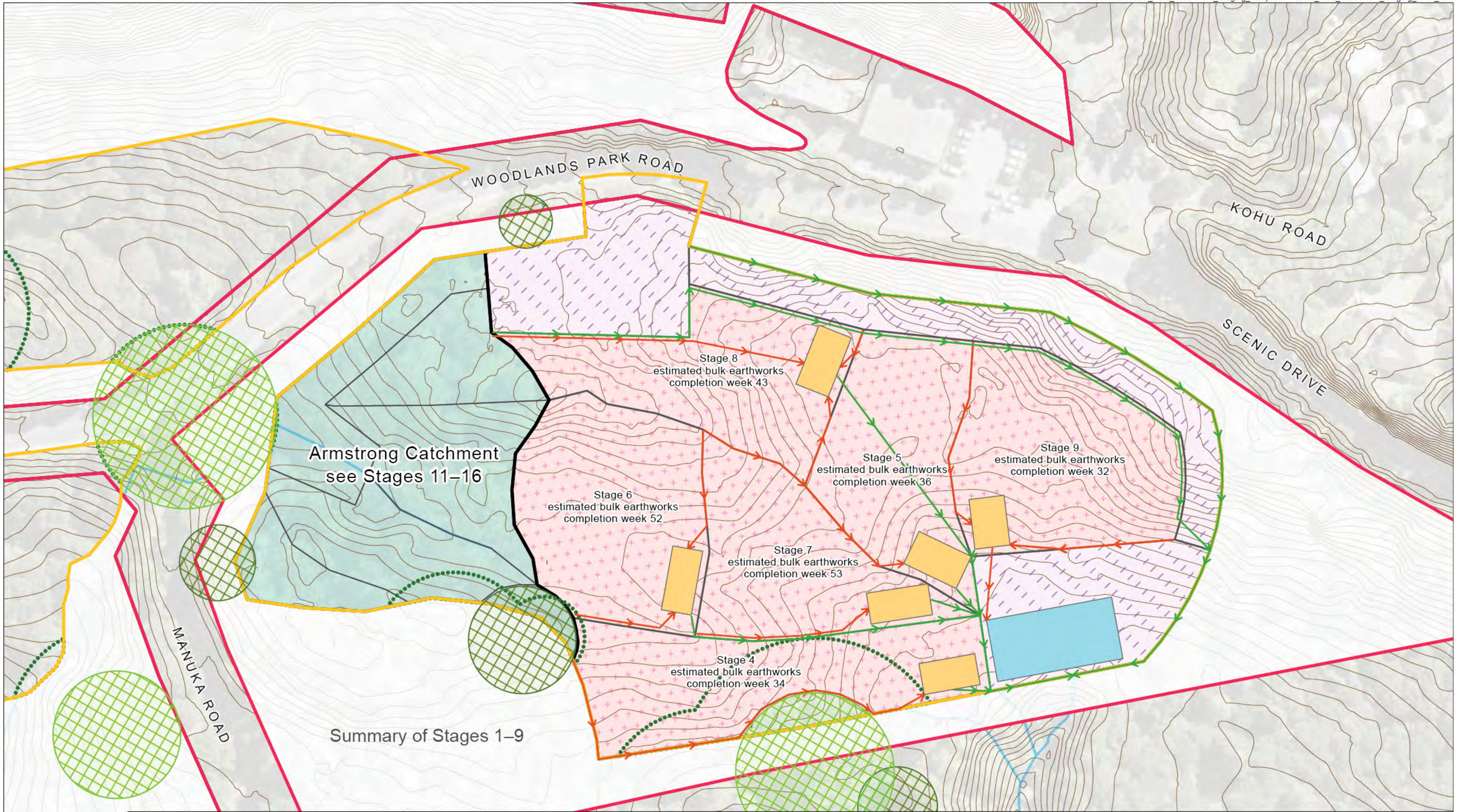
KEY STAGE OBJECTIVES\CRITERIA

- Completion of bulk earthworks operations within previous stages.
- Provide indicative timeframes/completion dates for stabilisation of catchments (earthworks completion).

KEY STAGE OPERATIONS

- Continue with bulk earthworks operations to subgrade level and stabilise.
- Upon stabilisation of each catchment stage remove sediment controls.
- The water collected from the washdown process (during the topsoil disposal and prior phases) will be collected and transported offsite.
- Once the site is "clean" i.e. topsoil disposal phase is completed, water would be treated to remove sediment load and then discharged downstream.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S10



Site Boundary	Extent of Earthworks
Subcatchment	Catchment Boundary
Topsoil Removal/Disposal	Bulk Earthworks Area
Stabilised Area	Slope Direction
1m Contour	Clean Water Diversion
Dirty Water Diversion	Indicative Existing Flow Paths
Decanting Earth Bund	Surface Water Containment Pond
Kauri Containment Zone	Root Protection Zone – Kauri
Root Protection Zone – Other (Non-Kauri) Trees	

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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 10

WATER TREATMENT PLANT SITE - STAGE 11

KEY STAGE OBJECTIVES\CRITERIA

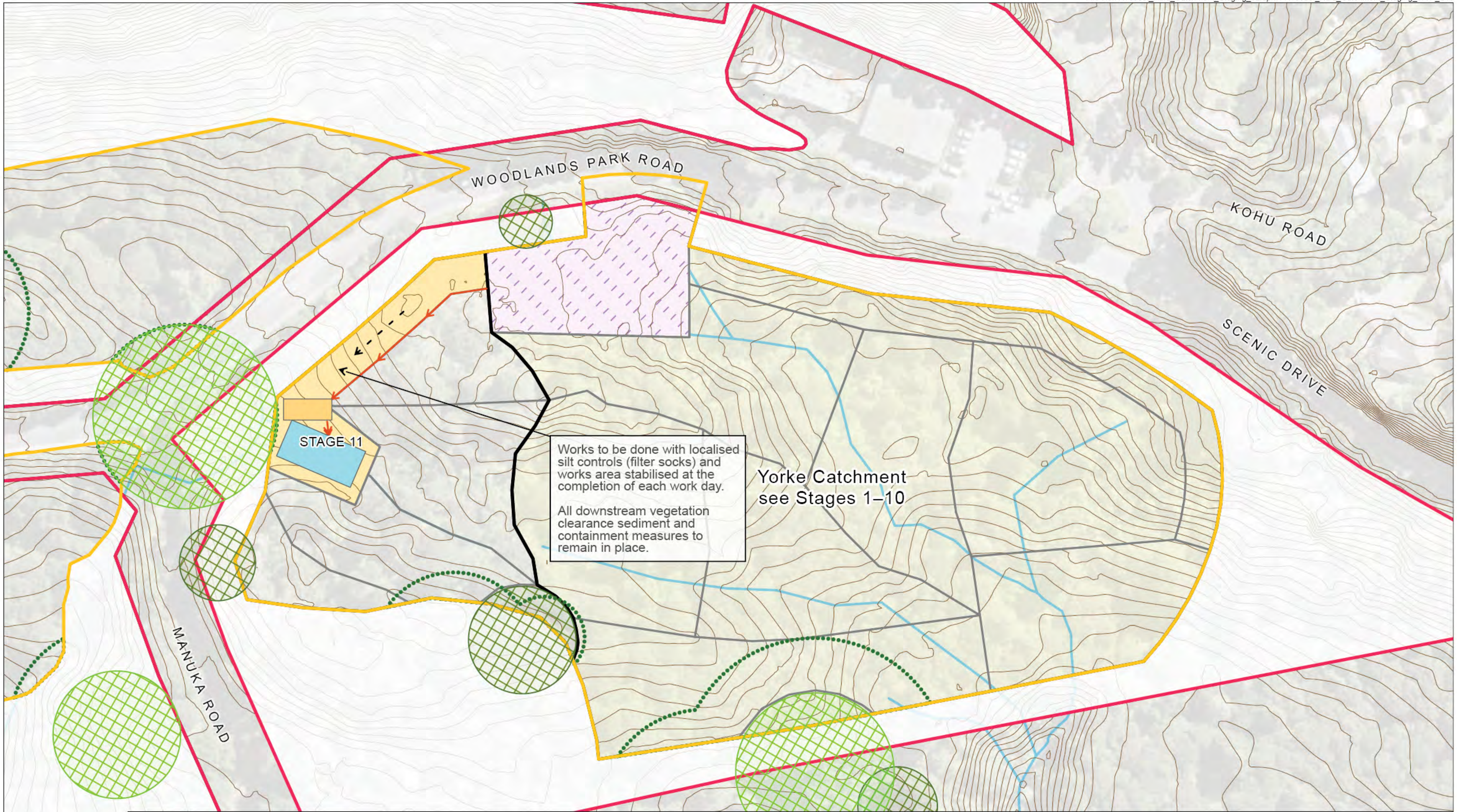
- Establish sediment pond which shall be used only for stormwater containment during topsoil removal phase (stage 12 to stage 15). All ponds shall be sized to contain at least the full 10- year storm event from the maximum proposed work area. The works area shall not exceed 3000m².
- All future work stages will utilise a two-stage treatment process. At source treatment for sediment shall be provided for each catchment with a decanting earth bund (DEB). Decanting earth bunds shall be sized based on 3% of the catchment area (as opposed to 2% (GD05)). Water shall then be discharge to SRP1 for containment/treatment prior to discharge to receiving environment.
- No topsoil removal/disposal catchment will exceed an area of 3000m²

KEY STAGE OPERATIONS

- Utilising existing access tracks and extend as necessary to allow for formation of SRP S2.
- Construct cleanwater diversion upstream of catchment.
- Construct SRP S2

EARTHWORKS VOLUMES

- Topsoil Removal 600m³
    - Cut 200m³
    - Fill 500m³
- Stage estimated timeframe - 3-4 weeks (includes 2 weeks for topsoil removal/disposal). Works can commence after week 6 of programme (completion of stage 1).



- Site Boundary
- Extent of Earthworks
- Subcatchment
- Catchment Boundary
- Topsoil Removal/Disposal
- Bulk Earthworks Area
- Stabilised Area
- Slope Direction
- 1m Contour
- Clean Water Diversion
- Dirty Water Diversion
- Indicative Existing Flow Paths
- Decanting Earth Bund
- Surface Water Containment Pond
- Kauri Containment Zone
- Root Protection Zone – Kauri
- Root Protection Zone – Other (Non-Kauri) Trees

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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 11

WATER TREATMENT PLANT SITE - STAGE 12

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S2 provides surface run off containment to mitigate potential spread of kauri dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

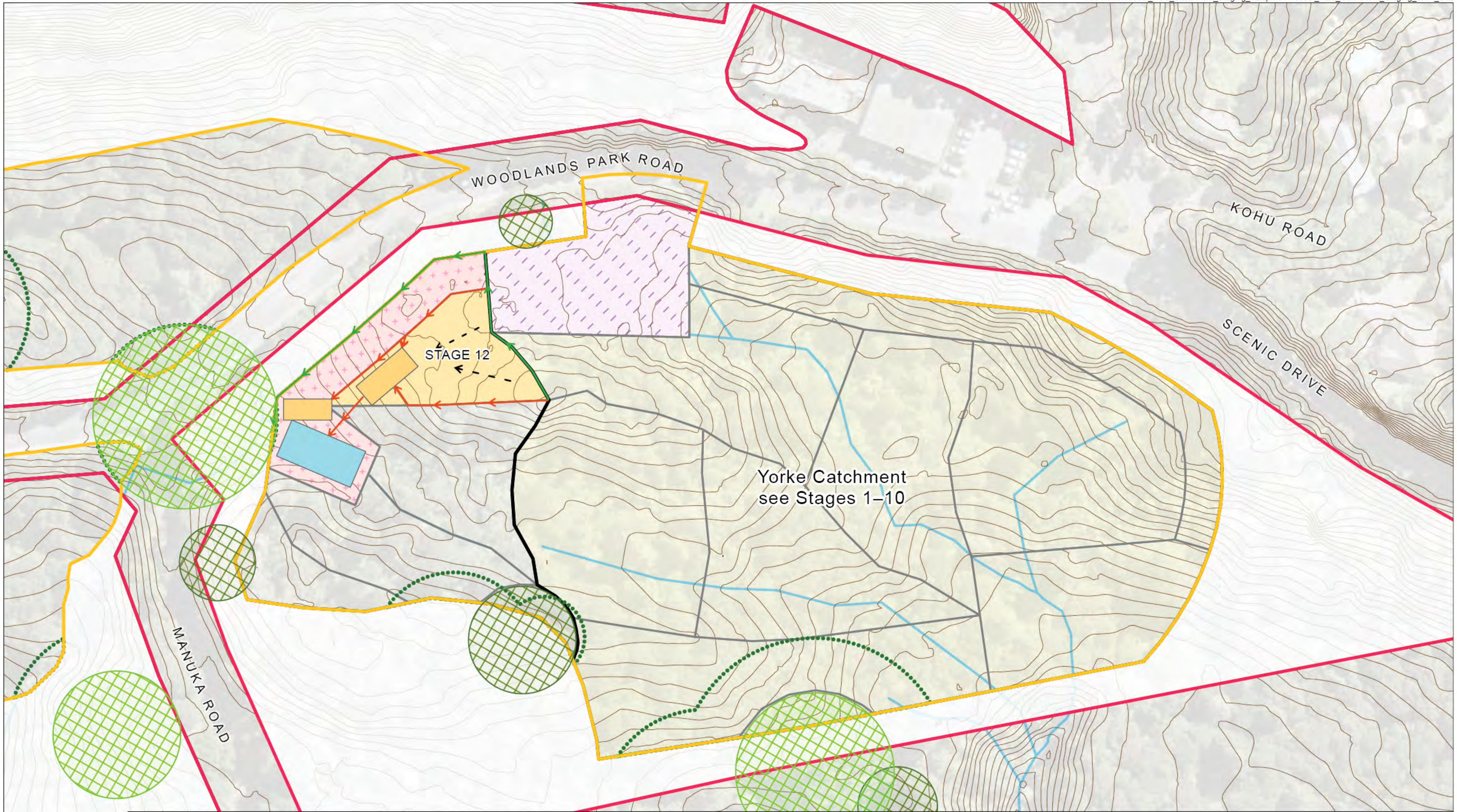
KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil Removal 510m³
  - Cut 3200m³
  - Fill 200m³
- Stage estimated timeframe - 16- 18 weeks (includes 2 weeks for topsoil removal/disposal). Works estimated to commence week 10 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S12



- Site Boundary
- Extent of Earthworks
- Subcatchment
- Catchment Boundary
- Topsoil Removal/Disposal
- Bulk Earthworks Area
- Stabilised Area
- Slope Direction
- 1m Contour
- Clean Water Diversion
- Dirty Water Diversion
- Indicative Existing Flow Paths
- Decanting Earth Bund
- Surface Water Containment Pond
- Kauri Containment Zone
- Root Protection Zone – Kauri
- Root Protection Zone – Other (Non-Kauri) Trees

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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 12

WATER TREATMENT PLANT SITE - STAGE 13

KEY STAGE OBJECTIVES\CRITERIA

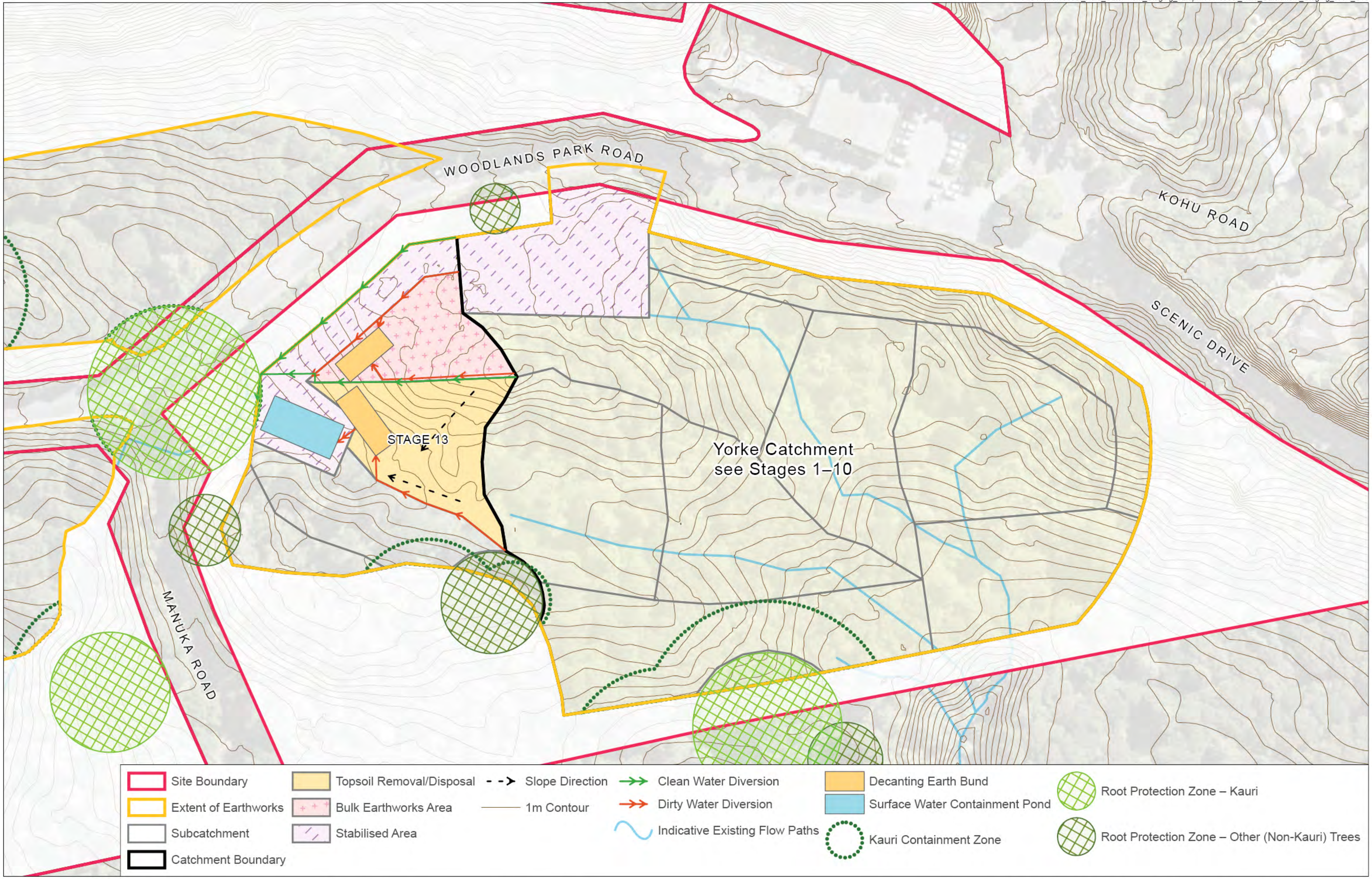
- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S2 provides surface run off containment to mitigate spread of kauri dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Works within the KCZ to be progressively excavated and hardfill hardstand extended into KCZ as works progress.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1] and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil Removal 750m^3
    - Cut 1300m^3
    - Fill 3500m^3
- Stage estimated timeframe - 16-18 weeks (includes 2 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 12 of programme.



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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

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Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 13

WATER TREATMENT PLANT SITE - STAGE 14

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S2 provides surface run off containment to mitigate potential spread of kauri dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

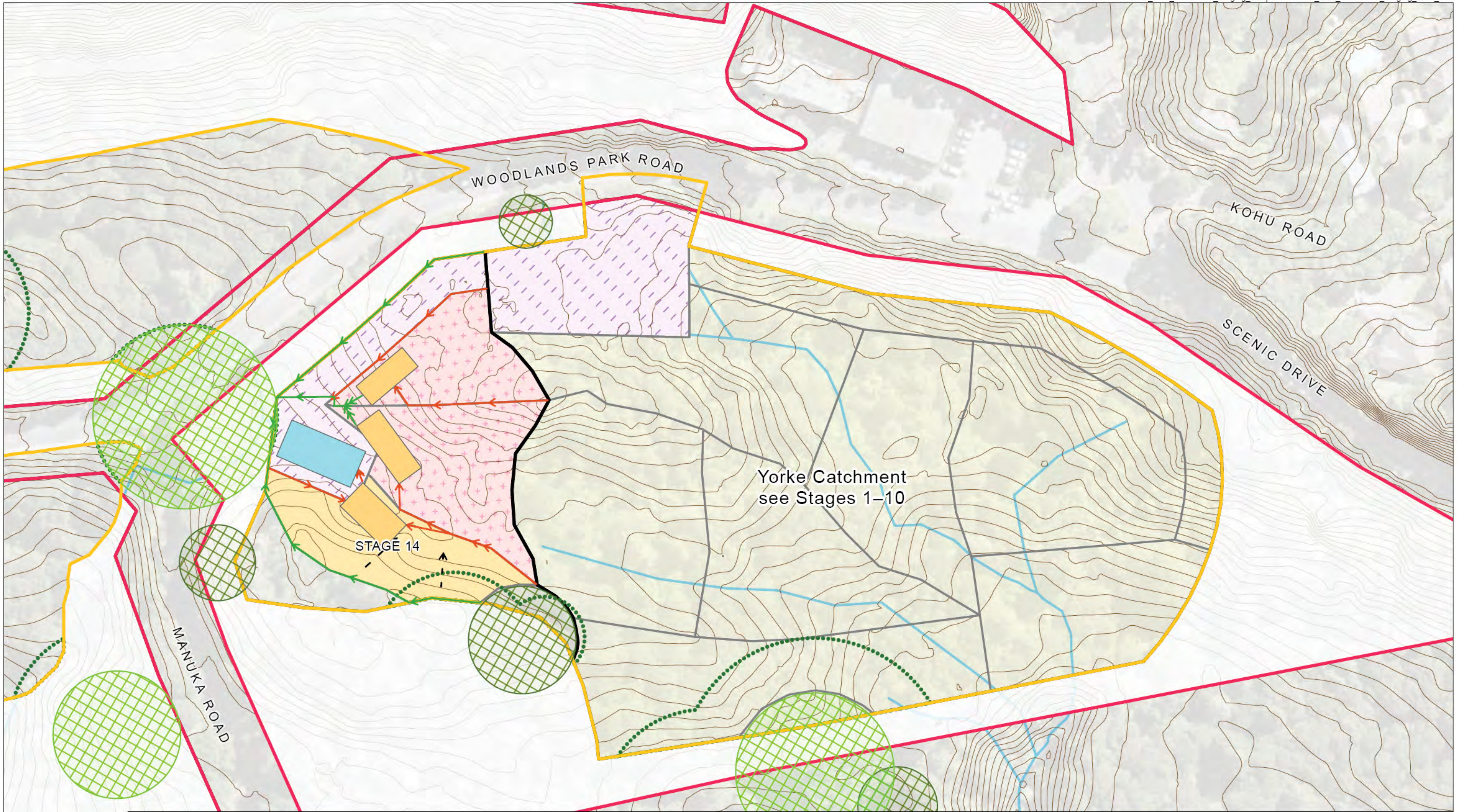
KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Works within the KCZ to be progressively excavated and hardfill hardstand extended into KCZ as works progress.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil Removal 650m^3
    - Cut 500m^3
    - Fill 2800m^3
- Stage estimated timeframe 8-10 weeks (includes 4 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 14 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S14



- Site Boundary
- Extent of Earthworks
- Subcatchment
- Catchment Boundary
- Topsoil Removal/Disposal
- Bulk Earthworks Area
- Stabilised Area
- Slope Direction
- 1m Contour
- Clean Water Diversion
- Dirty Water Diversion
- Indicative Existing Flow Paths
- Decanting Earth Bund
- Surface Water Containment Pond
- Kauri Containment Zone
- Root Protection Zone – Kauri
- Root Protection Zone – Other (Non-Kauri) Trees

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Data Sources: Boffa Miskell, LINZ, Auckland Council

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Date: 13 January 2020 | Revision: 0

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Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: ATy | Checked: SFI

Stage 14

WATER TREATMENT PLANT SITE - STAGE 15

KEY STAGE OBJECTIVES\CRITERIA

- Previous stage of topsoil removal within works catchment is completed prior to commencement of this stage.
- DEB provides sediment control while SRP S2 provides surface run off containment to mitigate potential spread of kauri dieback.
- Previous stages remain open for earthworking to final subgrade levels with sediment controls remaining in place.

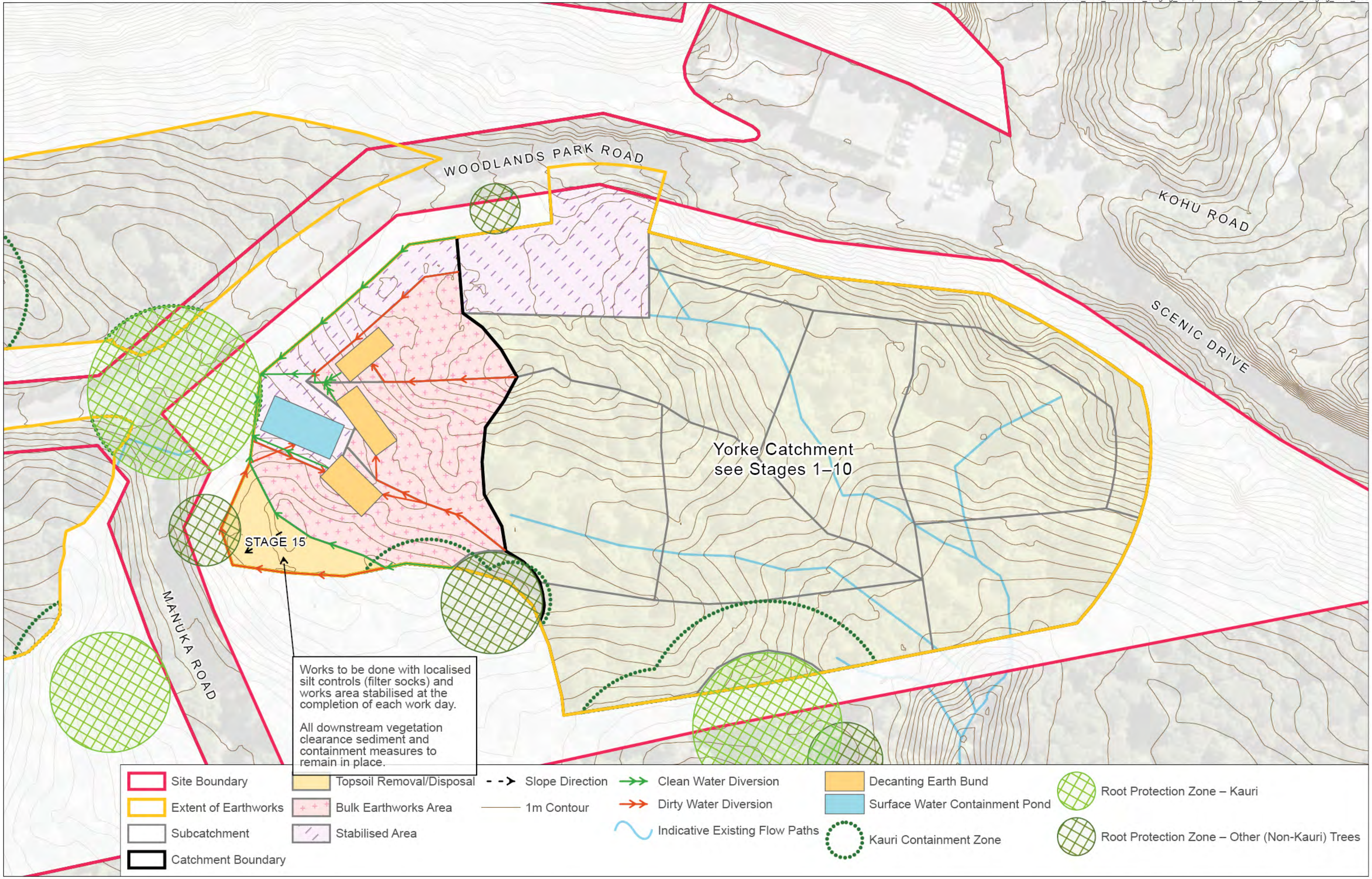
KEY STAGE OPERATIONS

- Establish cleanwater diversion upslope of disturbance area.
- Construct decanting earth bund and dirty water channels.
- Works within the KCZ to be progressively excavated and hardfill hardstand extended into KCZ as works progress.
- Excavate topsoil and any other potentially infected material to a nominal depth of 0.5 m plus 0.5 m subsoil[1], load directly onto trucks, cover and remove from site.
- Excavated material that is suitable for reuse to be placed in bulk earthworks area.

EARTHWORKS VOLUMES

- Topsoil Removal 300m³
    - Cut 750m³
    - Fill 50m³
- Stage estimated timeframe 4-6 weeks (includes 2 weeks for topsoil removal/disposal and works within KCZ). Works estimated to commence week 18 of programme.

File Ref: A16055I_Huia_Catchment_Staging_v2.aprx / A16055I_Huia_Catchment_Staging_WTP_S15



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Data Sources: Boffa Miskell, LINZ, Auckland Council

A16055G HUIA WTP ECOLOGY EVIDENCE AND HEARING

Topsoil Removal Disposal Phase Staging – Water Treatment Plant

Stage 15

Date: 13 January 2020 | Revision: 0

WATER TREATMENT PLANT SITE - STAGE 16

KEY STAGE OBJECTIVES\CRITERIA

- Completion of bulk earthworks operations within previous stages

KEY STAGE OPERATIONS

- Continue with bulk earthworks operations to subgrade level and stabilise.
- Upon stabilisation of each catchment stage remove sediment controls.