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Whangārei District Council
Glyphosate Use Review

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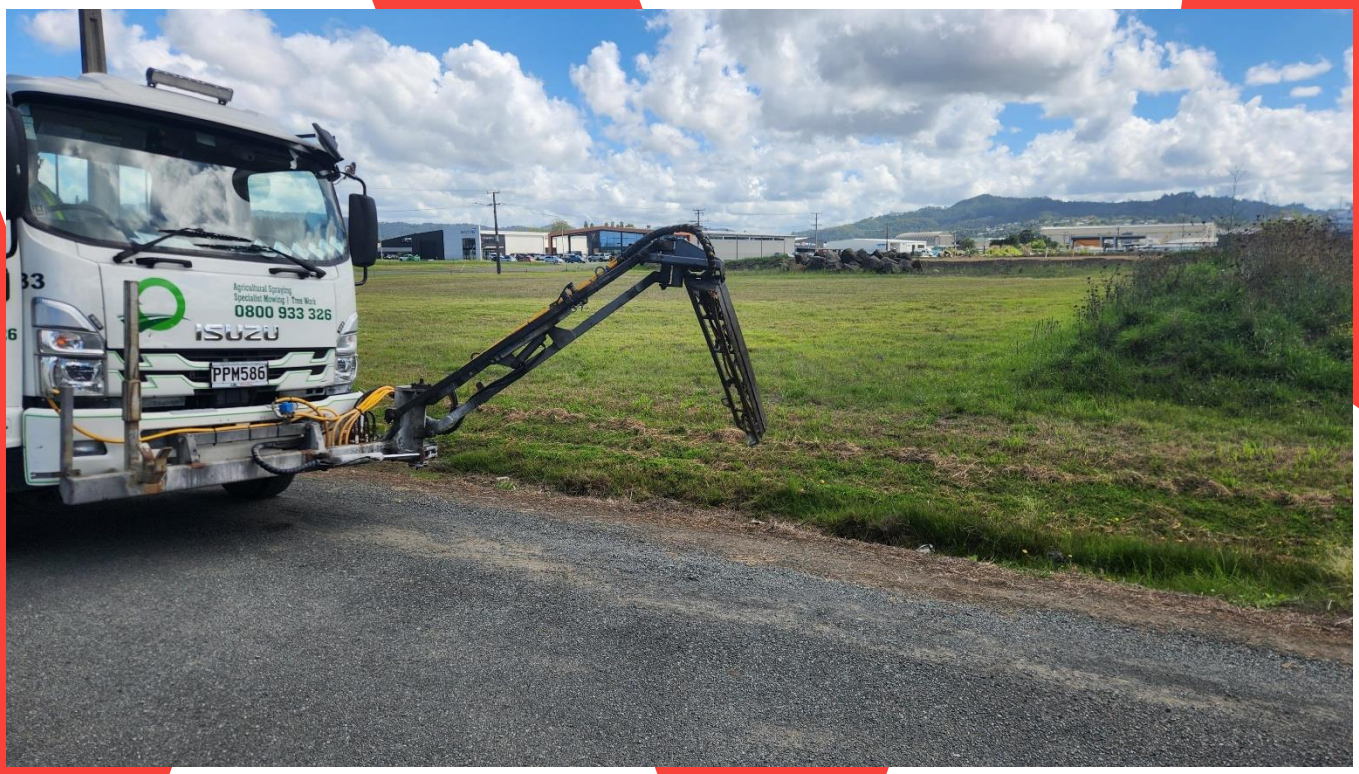

Glyphosate Use Review

Whangārei District Council

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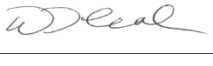
Approved by:	Wayne Teal	30/05/2025	

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GLOSSARY

WDC	Whangārei District Council
NZ EPA	New Zealand Environmental Protection Authority
US EPA	United States Environmental Protection Agency
ELI	Environmental Law Initiative
IARC	International Agency for Research on Cancer
HPS	High Pressure Steam
HWT	Hot Water Treatment

EXECUTIVE SUMMARY

Whangārei District Council (WDC) have received continuous requests not to use Glyphosate for weed control purposes. Glyphosate has been subject to public scrutiny for some time due to known and stipulated health concerns. This herbicide can also impact the natural environment due to spray drift and runoff. These adverse effects are most notable when poor herbicide application methods are used, indicating an opportunity to improve public perception by requiring more stringent health and safety protocols.

Accordingly, WDC have engaged WSP to assess Glyphosate's current use as a maintenance tool across council activities and investigate alternative weed control methods to consider as a substitute for Glyphosate. This review considers factors regarding costs, health implications and environmental effects of both Glyphosate and any suggested alternatives to facilitate the council's decision-making process. The review finds that Glyphosate remains the most effective and cost-effective weed control method, but health and environmental concerns may justify the selection of a more expensive alternative.

This review concludes by presenting three options for WDC to consider. (1) If Glyphosate use is continued, several recommendations are suggested to ensure that safe and efficacious application is adhered to. (2) Several alternative weed control methods are provided including indicative prices compared to Glyphosate. (3) Alternatively, Glyphosate use could be reduced but not entirely replaced by supplementing with the alternative methods to evaluate their effectiveness.

1 GLYPHOSATE OVERVIEW

1.1 SCOPE

Whangarei District Council (WDC) engaged WSP to conduct an extensive literature review on the current status and perspectives around the use of the herbicide, Glyphosate, to determine whether its use should be continued, and provide alternatives if not. This review will investigate the current use and efficacy of Glyphosate by WDC and compare this to the stance and approaches of other councils across New Zealand. Consideration will be given to public health concerns, environmental effects and cost implications to provide WDC with objective recommendations. This review's places significant focus on roadside spraying but extends to other Council managed areas such as parks and natural areas may be included when relevant. Finally, the review will also consider literature regarding "Glyphosate-based" herbicides which contain analogous compounds and equivalent function so will be referred to as Glyphosate from here on out.

1.2 INTRODUCTION

1.2.1 WHANGAREI DISTRICT COUNCIL CURRENT USE OF GLYPHOSATE

WDC appoint accredited contractors that use Glyphosate and other herbicides for weed control along the roadsides and within public parks under the approval and guidance of best practise for safety from the New Zealand Environmental Protection Authority (NZ EPA). Roadside spraying is applied three times annually, using spraying vehicles equipped with down-turned spray booms for localised application with minimal spray drift. Roadsides with pedestrian footpaths require precise weed control particularly along the expansion joins, achieved with a small 4x4 vehicle with a single fixed spray nozzle. Roadsides without footpaths require two meters of control from the road edge, achieved using a larger vehicle with an extendable boom arm fixed with several nozzles to span the required 2-meter width. Currently, WDC specifications do not regulate spray application near or over roadside drains which may feed into natural aquatic environments but there are specific herbicides tailored to reduce impacts on these ecosystems. It is expected that the applicators use these specific 'brews' when working near these susceptible environments. The specifications for this work do not define which herbicide must be used, but it is likely that Glyphosate is primarily chosen due to the target species, affordability and effectiveness. Within public parks, Glyphosate (and several other herbicide products) are primarily applied by using knapsack sprayers (Rowsell, 2018). Concentrations of Glyphosate are also not specified by WDC and are determined by the contractor based on manufacturer instructions – or label rates.

1.2.2 GLYPHOSATE INTENDED FUNCTION

Glyphosate is a synthetic organophosphorus compound known as phosphonate ($C_3H_8NO_5P$) used to kill unwanted plants in a range of contexts, including agriculture, horticulture, residential, and ecological remediation. This compound works by inhibiting the plant enzyme EPSP (5-enolpyruvylshikimate-3-phosphate synthase) required for the biosynthesis of essential aromatic amino acids, leading to a systemic breakdown of regular plant function (Schönbrunn et al., 2001). EPSP is only found in algae, plants, bacteria, and fungi, meaning that it does not have the same lethal and rapid implications if absorbed by animals (Schönbrunn et al., 2001). Glyphosate has the benefit of being a broad spectrum (non-selective) herbicide that is effective in most contexts, including annual and perennial plants because the EPSP metabolic pathway (known as the shikimate pathway) is shared by all plant species (Farmer, 2010).

1.2.3 GLYPHOSATE UNINTENDED IMPACTS

The widespread use of Glyphosate has produced sufficient selection pressure for the evolution of resistance to the herbicide, with a currently documented 48 weed species having developed several different molecular

adaptations to the compound (Baek et al., 2021). Consequently, glyphosate resistance may lead to the necessity for higher concentrations or volumes of application, increasing the level of spray drift or leaching, leading to a higher risk of impacting non-target native species which likely do not possess resistance (Boutin et al., 2014; Cederlund, 2017; Ferreira et al., 2023; Florencia et al., 2017). Furthermore, non-target effects extend beyond native plants, as ecotoxicity is reported in both aquatic and terrestrial environments, indicating ecosystem level impacts from Glyphosate (Klátyik et al., 2023, 2024).

Additionally, despite the absence of the shikimate pathway in the animal kingdom, glyphosate is known to impose inadvertent and harmful effects, notably being neurotoxic to humans and a range of other species (Costas-Ferreira et al., 2022). One meta-analysis found that the effects are sub-lethal but still severe and most prominently impacting aquatic animals (Evalen et al., 2024). Further, studies on a range of prominent animal groups (fish, birds and mammals) found impacts including endocrine disruption that inhibited ordinary reproductive hormone production, abnormal development of reproductive tissue, reduction in gamete production and higher embryo mortality (Jarrell et al., 2020). Additionally, Glyphosate impacts mycorrhizal fungi and Annelids (earthworms) which are both important components of healthy soil (Gill et al., 2017). Glyphosate also impacts herpetofauna (lizards and amphibians) and arthropods – including the class Insecta which consists of many ecologically and economically important pollinators, seed dispersers, predators, and detritovores (Gill et al., 2017). These impacts are vast, but other herbicides may have similar trade-offs. Accordingly, the impacts of glyphosate must be compared to any alternative herbicide to determine the most appropriate option.

These negative impacts subsequently elicit public apprehension to the continued use of Glyphosate. Currently, NZ EPA holds the stance that Glyphosate is safe for use if guidelines are followed (NZ EPA, n.d.). However, this outlook is not shared by everyone, and 379 ACC claims associated with Glyphosate exposure have been accepted since 1990 and a further 60 have been declined (Martin, 2025). Further, ongoing concerns are raised about the uncertainty regarding Glyphosate's carcinogenic status (Mead, 2021), with the United States Environmental Protection Agency (US EPA) concluding that it is not likely to be carcinogenic, while the International Agency for Research on Cancer (IARC) concluded that it likely is carcinogenic (Benbrook, 2019). The IARC's research methodology and results were found to be much more reliable (Benbrook, 2019). Contrarily, Morini (2018) points out that this discrepancy is due to the IARC reporting the hazard while the EPA reports the risk (factoring in probability of exposure at high enough levels to cause cancer). Because the US EPA has held their stance on Glyphosate safety (US EPA, 2025), other entities internationally including the NZ EPA have continued to cite this stance as a justification for continued support of the substance (NZ EPA, 2024; Temple, 2016). Additionally, the NZ EPA's 2016 report produced in disagreement to IARC's findings followed a scientifically flawed approach and cannot be relied upon (Douwes et al., 2018). The NZ EPA's stance is currently being challenged by the Environmental Law Initiative (ELI) for not regulating Glyphosate with proper precautions (ELI, 2024). These disagreements in Glyphosate safety indicate the sensitive nature of this issue, with a lack of definitive evidence and potentially a failure to follow objective scientific approaches.

1.2.4 SAFE USE, FREQUENCY AND EXTENT OF EXPOSURE

These literature findings provide strong evidence that Glyphosate is a hazardous substance that can have severe impacts on human health and the environment. However, it is important to consider the risks of Glyphosate use when suitable health and safety protocols are followed at the typically low frequency required to maintain adequate vegetation control. Specifically, the low frequency of exposure to the public from routine spraying likely has insignificant implications if spray drift is sufficiently controlled. Contrarily, frequent exposure to spray applicators working on a daily basis may have more significant adverse effects. Accordingly, attempts to further reduce exposure to the general public may only improve public relations with only minimal improvements to public health. Meanwhile, the health and safety procedures employed by spray applicators may be much more important but should remain the responsibility of the contractor and not WDC.

The literature indicates that Glyphosate impacts aquatic environments, soil ecology, and important invertebrates. However, WDC's current needs for Glyphosate are localised to areas requiring vegetation control, including the roadside and park areas of high weed prominence. Accordingly, much of the wider landscape

remains beyond the extent of spraying activities, providing unaffected population refuges for species impacted within sprayed areas. Additionally, areas requiring spray are inherently of lower ecological value, because the open disturbed habitats facilitate the establishment of exotic species. These environments are unlikely to contain threatened endemic species that are typically confined to less modified systems. Ultimately, if Glyphosate is applied in a manner that avoids spray drift, leaching, and runoff into non-target environments, then it is unlikely that its use will have severe impacts at a broader population or environmental scale.

1.2.5 REVIEW OUTLINE

The range of severe impacts that Glyphosate can cause justifies the following investigation. For the reported effects of Glyphosate that are not universally agreed upon (such as carcinogenic status), the Precautionary Principle should be employed until a definitive consensus is reached. Accordingly, it should be assumed that Glyphosate is carcinogenic until proven otherwise. Furthermore, if ELI are successful, Glyphosate may become more heavily regulated or banned entirely as has already occurred in several countries. However, this review will investigate whether current best practise for the application of Glyphosate sufficiently mitigates the identified risks, in which case continued use may be acceptable. Further, if current approaches are not sufficient, further health and safety protocols will be considered to determine whether these risks can be plausibly mitigated. This review will also investigate the approaches of other councils in New Zealand determine whether effective alternative methodologies or herbicides could be adopted by WDC. Finally, the cost, efficacy, and risks of other herbicides/control measures will be compared with Glyphosate to provide alternative options for WDC.

2 BEST PRACTICE FOR SAFE GLYPHOSATE USE

2.1 CURRENT PROTOCOL FOR GLYPHOSATE USE

The specifications for spraying provided by WDC to the client do not define all health and safety practises to be followed by the contractor as it is expected that the contractor is following suitable safety measures. Specifically, WDC requires that the contractor follows manufacturer instructions and is a certified spray applicator. Accordingly, it will be assumed here that the contractors are currently following standards specified by the NZ EPA as the governing body in New Zealand for the regulation of this substance.

2.1.1 EPA GUIDELINES

The following is retrieved directly from NZ EPA (NZ EPA, 2015):

Before you spray

- *Read all instructions on the label and follow them.*
- *Make sure you are using the right product for the job you are doing.*
- ***Confirm your spray area is not close to water, standing water that flows to streams, rivers, lakes or ponds.***
- *Check the weather forecast. Make sure no rain is predicted for at least 24 hours. Avoid spraying when it is windy.*
- *Clear children and pets from the area and keep them well away.*
- *Follow the label advice on the need for protective clothing.*

After spraying

- *Wash your hands, face and clothing.*
- *Keep children and pets away until the spray has dried, or for the amount of time indicated on the label.*
- *Read the instructions on the label to help you safely dispose of any unused product and packaging.*

2.1.2 WDC ROADSIDE SPECIFICATION

WDC's roadside specification provides some additional requirements of the contractor to avoid some environmental damage and harm to public health. A summary of these specifications include:

- not spraying areas that rely on vegetation for soil stability.
- Precise nature of herbicide application, including widths of roadside to be sprayed, ranging from 2 meters to 50mm depending on the type of roadside.
- Not spraying within 5 meters of people or animals.
- Not spraying directly upwind of people or animals.
- Not spraying in winds over 10kph.
- Alternatives are considered before herbicide is used.
- Timing is considered to avoid busy periods.

- Informing public through use of signage and public notices in local newspapers.

2.2 SUFFICIENCY OF CURRENT PROTOCOL

There is currently reasonable consideration towards ensuring public health and safety while applying herbicides. However, these considerations are built around the NZ EPA's stance that Glyphosate is not carcinogenic. Should the EPA's stance be revised, the current level of care may require re-evaluation.

2.2.1 CONCERNS WITH CURRENT APPROACH

1. There is currently a high level of care afforded to public health if all specifications are followed correctly. Unfortunately, some of these specifications can be easily overlooked or expedited as may have occurred during the events investigated on the 20th of October 2021 when 3 children were allegedly caught in spray drift on Mill Road, Whangarei. For this to occur, the contractor would have had to failed to adhere to the specification of not spraying within 5 meters of people or animals. The exact reasoning for this failure to follow specifications was not determined in the formal investigation and numerous variables could have contributed to this scenario. However, one potential variable was not discussed in this formal investigation: being near the end of the workday, it is possible that the contractor was in a hurry to finish work. This assumption would be exacerbated by the basis of payment to the contractor which is determined by the number of kilometers/volumes sprayed. This basis of payment could inadvertently incentivize skipping over safety measures to improve efficiency (kilometers sprayed per hour). It is important to note that the formal investigation found that the children were not directly sprayed by the vehicle but there is potential for them to have intercepted some spray drift.
2. The Specification defines that no spray application shall occur directly upwind of people or animals, but no distance is provided and is therefore left up to interpretation by the contractor.
3. The Specification does not define a maximum height for the spray wand to be held above the ground or desired target. Spray boom height is known to be a significant contributing factor for spray drift in an agricultural context (Nordby & Skuterud, 2006) and will also likely have influence for roadside application. Additionally, spray droplet size was found to be a strong predictor of spray drift, with droplets ≤100 µm contributing disproportionately to spray drift (Arvidsson et al., 2011). Factors determining droplet size are also not defined in the Specification.
4. The NZ EPA inform to keep people and animals away from sprayed surfaces until the herbicide has dried (withholding period). There is no peer reviewed literature to back up that Glyphosate becomes safe to humans once it is dry. Contrarily, studies have shown that Glyphosate can persist within sprayed vegetation for up to a year after application (Edge et al., 2021). Accordingly, this claim that Glyphosate is safe once dry should be taken with scepticism.
5. The level of consideration towards the environment is not as comprehensive as for health and safety. One discrepancy has been identified between the EPA guidelines and the WDC Specification. It is stated by EPA that spraying should not be conducted near water bodies to avoid damaging aquatic ecosystems. However, the WDC Specification states that spraying should include all culverts and water tables. This approach may be ok for some structures, including under favourable 'dry conditions', but care must be taken as some culverts and water tables may also meet the definition of a "stream" or "intermittently flowing stream" as set out in the Regional Plan (Northland Regional Council, 2024). One study found that urban use of Glyphosate contributes significantly to Glyphosate concentrations in streams (Kolpin et al., 2006).

2.3 RECOMMENDED ADDITIONAL MEASURES

Due to the disparity in stances held between the NZ EPA and most peer-reviewed scientific literature around the safety of Glyphosate and the current political conflict between NZ EPA and ELI, it is recommended that alternative methods of weed control are investigated. Notably, if ELI are successful, Glyphosate could become much more heavily regulated, and a complete ban could be possible as is already the case in several other countries. Accordingly, it would be beneficial to begin contemplating alternatives before any regulatory changes occur. However, if alternatives are not logistically feasible and regulatory changes do not eventuate, the following recommendations are provided to further improve the safety of Glyphosate use for both public health and the environment:

1. Contractors should be compensated for standby time if safety requirements temporarily halt spraying activities (e.g., pedestrians using a stretch of path). This potential extra cost should be considered as an investment towards public health and assurance of care afforded to the safe use of hazardous chemicals.
2. A minimum spraying distance upwind of people or animals should be specified. With sufficient spray drift controls in place (see recommendation 3) 10 meters could be sufficient. This could include exclusion zones in the form of signage and greater supervision to exclude public.
3. One current contractor's vehicle appears to have the spray wand fixed sufficiently close to the ground which should minimise spray drift. The Specification should still define a maximum height that herbicide can be sprayed above the ground to ensure that any change in contractor or equipment is held to the current standard. The Specification should also require that the proportion of droplets less than 100µm is kept to a minimum as these smaller droplets contribute disproportionately to spray drift (Arvidsson et al., 2011). A suggested acceptable percentage of droplets below 100µm could be <10%. Droplet size is determined by spray nozzle design so may require a change in equipment. Additionally, the use of adjuvants or surfactants can help increase droplet size (Basílio et al., 2024).
4. Temporary signage erected in parks during spraying may need to remain for a longer period to give sufficient time beyond the current drying period for Glyphosate to break down or be washed off by rain.
5. If any structures (culverts, water tables, etc.) are known to feed into a receiving aquatic ecosystem (including but not limited to streams, rivers, wetlands, ponds or lakes) Glyphosate should not be used due to the severe impacts known to these environments (Evalen et al., 2024; Klátyik et al., 2024).

2.4 WEED CONTROL BY OTHER COUNCILS

A review of all other councils across New Zealand was undertaken to determine the stances held around Glyphosate. The key findings are summarised within Appendix A. These findings provide evidence that some alternative approaches are being pursued elsewhere in the country and may provide WDC with additional options to consider.

2.5 SUMMARY

The uncertainty around Glyphosate safety and the impending potential regulatory changes makes it imperative that alternative weed control methods are considered. However, while alternatives with similar efficacy are investigated, five additional measures have been recommended to improve safety if Glyphosate use continues.

3 CONTRACTOR GLYPHOSATE PERSPECTIVE AND BEST PRACTISE RECOMMENDATIONS

Team Vegetation is one contractor used by WDC for vegetation control. An interview with the former owner and current safety and HR manager of this company, Don Campion, was conducted on the 28th of February to gain a contractor's perspective around the use of Glyphosate. Team Vegetation is a multigenerational business that has been operating since the 1970's and has continued to retain repeat clientele by providing effective weed control solutions while maintaining crucial health and safety precautions. This reputation is essential to the ongoing viability of the company as any poor performance or breaches in health and safety protocol could result in the loss of contracts and continued business. Team Vegetation made it clear that these implications provide clear incentives to hold their services to a high standard.

To retain this reputation, Team Vegetation keep detailed documentation of site safety plans, spray diaries recorded at 15-minute intervals, and automatic GPS tracking records when spraying is active/inactive. These records help facilitate audits from several organisations, including WorkSafe every 2 years, and Site Safe NZ every 5 years. These audits ensure safe practise is followed in all aspects of business operations from spray application to herbicide storage. Team Vegetation reported that they have continued to receive the highest ratings for safety due to their stringent attention to record keeping and to the high-quality equipment implemented in the spraying process.

The equipment used has been selected and refined over years of research and development to improve application efficiency and accuracy while reducing spray drift and the quantity of herbicide used. Firstly, the selection of spray nozzles has been carefully considered to reduce the occurrence of small droplets (<150µm) that are highly susceptible to spray drift. These nozzles are also chosen and fixed for precise directionality to ensure herbicide is only applied where required. Secondly, quantity is applied at a variable rate depending on the speed of the vehicle, ensuring that overapplication does not occur along slower sections of road. Further, the spray boom arm consists of several individually controlled spray nozzles that allow for changing the application width along the road verge depending on the task and local environment.

Team Vegetation provided WSP with a demonstration of their equipment during the interview. WSP was satisfied with the efficacy of the herbicide application as there was no spray drift visible during the demonstration despite the presence of light wind. Additionally, the accuracy of application was precise and evenly spread. WSP is confident that if all contractors engaged by WDC are held to the standards demonstrated by Team Vegetation that the health concerns regarding glyphosate can be reasonably minimised.

4 COMPARISON OF ALTERNATIVES

4.1 GLYPHOSATE COSTS

In Auckland's road corridor, Glyphosate costs an average of **$562 per km per year**, ranging from $300-$779 per km per year depending on site conditions (FYI NZ, n.d.).

4.2 ALTERNATIVE CHEMICALS

Other herbicide compounds are known to be more toxic/ecotoxic than Glyphosate, less effective, and typically cost more so WSP cannot recommend an alternative that can reasonably substitute the efficacy of Glyphosate (Neal & Senesac, 2024). Notably, the lower efficacy of alternative herbicides will necessitate a higher annual frequency of application. This higher frequency will result in greater exposure to applicators and the general public, increasing health concerns compared to Glyphosate. The only option with reported low ecotoxicity include the natural alternatives which are much less effective, more costly, and remain a severe concern to human health. Finally, Glyphosate remains the only effective non-selective herbicide, meaning that switching to alternatives would require the use of multiple different products to achieve a similar broad-spectrum kill. The use of several hazardous chemicals at a higher frequency as a replacement to Glyphosate would potentially be regressive. A summary produced from a 2024 review of alternatives is provided in Table 1.

Table 1: A summary of the advantages and disadvantages of Glyphosate and it's alternatives reported by Neal & Senesac (2024).

Herbicide	Advantages	Disadvantages
Glyphosate	**Inexpensive.** Rapidly deactivated when in contact with soil. **Non-selective** (controls most plants). **Systemic** (travels to roots, preventing reemergence).	Public disapproval. Some negative health effects. Potential carcinogen.
Glufosinate	Effective on annual species. Lower occurrence of non-target contamination	Does not travel to roots (regrowth of perennial species likely)
Diquat	Effective and relatively cheap on small annual species. Spray drift effects not severe.	Large annual and perennial species not killed.
Pelargonic acid	Effective on broadleaf seedlings. **Very effective in warm weather**. Spray drift will not kill non-target plants.	Large annual and perennial species not killed. Not effective in cold weather. **High cost**. Less effective than Diquat. Persistent and offensive odour. Severe eye irritant.
Natural Alternatives (Fatty Acids, Vinegar etc.)	Organic and less ecotoxic.	Natural does not mean safe – high dermal toxicity (skin irritant). Does not spread to roots – no long-term kill. Significantly more expensive. Bio-Safe herbicide costs **$1,459 per km per year** (FYI NZ, n.d.).

4.3 THERMAL WEED CONTROL

High Pressure Steam (HPS) and Hot Water Treatment (HWT) are two methods of thermal weed control used elsewhere.

CityCare Whangarei informed WSP that steam treatment is possible but typically must be applied at twice the frequency of Glyphosate and will cost **4 to 6 times more per meter**. Additionally, CityCare has reported that complete implementation of this method could take roughly 3 to 6 months to allow time to invest in the necessary equipment and train staff.

HPS is used in conjunction with regular HWT along a large section of Auckland's North Shore Road corridor. For HPS, the costs equate to **$1,561 per km per year** whereas HWT would cost **$2,372 per km per year** if applied at the rate necessary to achieve full control (FYI NZ, n.d.). The cost of HPS reported here is about 3 times the cost of Glyphosate, however, this steam cost is reported as being supplemented by Glyphosate and mechanical treatments, so CityCare's quote of 4-6 times is likely more indicative of the true costs. HPS uses 2000-3000 litres of water per day while HWT uses double this amount which should be considered if water shortages are anticipated (FYI NZ, n.d.). The carbon footprint produced by heating water for both methods has not been quantified but should be investigated if this approach is considered. Ecological impacts include damage to the soil fauna biodiversity. However, impacts on soil fauna will be localised to areas in direct contact with the applied heat. Contrarily, Glyphosate is also known to impact soil biodiversity but also risks runoff and spray drift which could impose a broader extent of non-target damage. Health implications involve the risk of burns and vehicle strike due to operators walking alongside the vehicle within the road corridor (FYI NZ, n.d.). These methods will likely not kill off all roots, so reemergence is likely to be rapid, explaining the suggested frequency being double that of Glyphosate.

4.4 MECHANICAL/MANUAL

Mechanical methods are most effective when combined with other methods such as herbicide or steam (FYI NZ, n.d.). The cost for mechanical only control within the road corridor is estimated to be about **$2,000 per km per year** (FYI NZ, n.d.). This cost is difficult to estimate due to current implementation of mechanical methods being supplemented by other methods, so costs could be higher for an exclusively mechanical approach. Disadvantages include the transfer of weed fragments and seeds on equipment, spreading invasive species faster than normally expected (Tu et al., 2001). Additionally, mechanical methods will not remove or kill rootstocks which will readily regrow requiring a higher frequency of implementation. Health risks are limited to the operation of machinery as no toxic chemicals are implemented.

4.5 SUMMARY

The above comparison of alternatives demonstrates that Glyphosate remains the most effective and cheapest method for the control of weeds in the urban road corridor. Table 2 summarises the findings.

Table 2: A summary of the findings from Section 4 with costs based on Auckland data.

Method	Cost	Advantages	Disadvantages
Glyphosate	**$562 per km per year**	Long-term kill (lower frequency of application). Non-selective.	Public perception. Potential carcinogen.
Alternative Herbicides	**$1,459 per km per year**	Some are less ecotoxic. Fewer non-target impacts.	Potentially more harmful to human health. Not non-selective (cannot control all problematic species). Higher frequency of application required due to shorter-term kill.
High Pressure Steam	**$1,561 per km per year**	No toxicity/ecotoxicity.	Excess carbon footprint. May need supplementary control in the form of herbicide and mechanical methods. Higher frequency of application required.

Hot Water Treatment	**$2,372 per km per year**	No toxicity/ecotoxicity.	Excess carbon footprint. May need supplementary control in the form of herbicide and mechanical methods. Higher frequency of application required.
Mechanical	**$2,000 per km per year**	No toxicity/ecotoxicity.	Cost estimate may not be accurate. Higher frequency of application required. May need supplementary control in the form of herbicide application.

5 RECOMMENDATIONS AND CONCLUSIONS

5.1 SUMMARY

Glyphosate has been subject to public condemnation for some time due to known and stipulated health concerns. The use of this herbicide can also impose some serious effects on the natural environment due to spray drift and runoff. Importantly, many of these adverse effects are exacerbated by poor herbicide application methods which may be a result of poor training, lack of stringent safety protocol, or incorrect equipment. This review has found that Glyphosate remains the most effective and cheapest weed control, but health and environmental concerns may justify the selection of a more expensive alternative.

Accordingly, this review presents three options for WDC to consider. (1) If Glyphosate use is continued, several recommendations are suggested in 5.2 to ensure that safe and efficacious application is adhered to. (2) Several alternative weed control methods are provided in 5.3 including indicative prices compared to Glyphosate. (3) Alternatively, Glyphosate use could be reduced but not entirely replaced by supplementing with the alternative methods to evaluate their effectiveness.

5.2 GLYPHOSATE RECOMMENDATIONS

If Glyphosate use is continued, the following recommendations should be implemented to ensure safe use of this hazardous chemical:

1. Contractors should be paid for standby time if safety requirements temporarily halt spraying activities (e.g., pedestrians using a stretch of path). This potential extra cost should be considered as an investment towards public health and assurance of care afforded to the safe use of hazardous chemicals.
2. A minimum spraying distance upwind of people or animals should be specified. With sufficient spray drift controls in place (see recommendation 3) 10 meters could be sufficient. This could include exclusion zones in the form of signage and greater supervision to exclude public.
3. The current contractor's vehicle appears to have the spray wand fixed sufficiently close to the ground which should minimise spray drift. The Specification should still define a maximum height that herbicide can be sprayed above the ground to ensure that any change in contractor or equipment is held to the current standard. The Specification should also require that the proportion of droplets less than 100µm is kept to a minimum as these smaller droplets contribute disproportionately to spray drift (Arvidsson et al., 2011). A suggested acceptable percentage of droplets below 100µm could be <10%. Droplet size is determined by spray nozzle design so may require a change in equipment. Additionally, the use of adjuvants can help increase droplet size (Basílio et al., 2024).
4. Temporary signage erected in parks during spraying may need to remain for a longer period to give sufficient time beyond the current drying period for Glyphosate to break down or be washed off by rain.
5. If any structures (culverts, water tables, etc.) are known to feed into a receiving aquatic ecosystem (including but not limited to streams, rivers, wetlands, ponds or lakes) Glyphosate should not be used due to the severe impacts known to these environments (Evalen et al., 2024; Klátyik et al., 2024).

Additionally, the high standards demonstrated by Team Vegetation (Section 3) should be expected of any contractors hired to spray Glyphosate.

5.3 SUGGESTED ALTERNATIVES

If Glyphosate use is discontinued (or reduced), the following alternatives are summarised with advantages, disadvantages and costs to aid in decision making (Table 3). It is noted that alternative herbicides are not recommended as a complete substitute for Glyphosate due to alternatives typically being a more severe hazard to human health while also being less effective.

Table 3: A summary of the findings from Section 4 with costs based on Auckland data.

Method	Cost	Advantages	Disadvantages
Glyphosate	**$562 per km per year**	Long-term kill (lower frequency of application). Non-selective.	Public perception. Potential carcinogen.
Alternative Herbicides NOT RECOMMENDED	**$1,459 per km per year**	Some less ecotoxic. Non-target impacts fewer.	Potentially more harmful to human health. Not non-selective (cannot control all problematic species). Higher frequency of application required due to shorter-term kill.
High Pressure Steam	**$1,561 per km per year**	No toxicity/ecotoxicity.	Excess carbon footprint. Needs supplementary control in the form of herbicide and mechanical methods. Higher frequency of application required.
Hot Water Treatment	**$2,372 per km per year**	No toxicity/ecotoxicity.	Excess carbon footprint. Needs supplementary control in the form of herbicide and mechanical methods. Higher frequency of application required.
Mechanical	**$2,000 per km per year**	No toxicity/ecotoxicity.	Cost estimate may not be accurate. Higher frequency of application required. May need supplementary control in the form of herbicide application.
No Treatment NOT RECOMMENDED	**Indirect costs e.g.: Increase in staff time handling ratepayer complaints concerns**	No toxicity/ecotoxicity.	Not treating the problem. Not applicable everywhere. Increased risks to public arising from problematic plants and weeds blocking and obscuring access and sightlines. Loss of local aesthetics. Increase of invasive and pest species which displace NZ natives.

6 APPENDIX A

A summary of Glyphosate stances across New Zealand councils. Councils in **bold** have approaches that may be worth some consideration by WDC.

Regional	Council	Notes
Northland	**Far North District Council**	Review of alternatives to Glyphosate found that costs would be about 6 times more expensive (Rokobigi, 2024). Contractor trialling alternative herbicides (Soil and Health Association, n.d.).
	Kaipara District Council	Glyphosate is used, no evidence of considering alternatives.
	Whangarei District Council	5% of roadside controlled by mechanical mowing and reserves are 80% controlled with Glyphosate (Soil and Health Association, n.d.). Compare to Waipa District Council below
	Northland Regional Council	Glyphosate is used, no evidence of considering alternatives.
Auckland	**Auckland Council**	Some boards are using thermal and mechanical methods which is more expensive and has higher carbon emissions due to heating methods (Auckland Council, 2020). Mechanical control is 3 times more expensive and thermal control is 3-6 times more expensive per meter in parks or the road corridor (Auckland Council, 2021). The council did reconsider Glyphosate use but has continued (RNZ, 2017). Later the council has considered increasing Glyphosate use for cost purposes (Dillane, 2020). The Auckland Council also reported that alternative herbicides cost more and require greater quantities to be as effective as Glyphosate (Auckland Council, 2021).
Waikato	Hamilton City Council	Uses Glyphosate (Hamilton City Council, n.d.). No further information available on stance.
	Hauraki District Council	No information available. Likely uses Glyphosate.
	Matamata-Piako District Council	Trialling no spray areas (Soil and Health Association, n.d.).
	Otorohanga District Council	“Spraying of open drains is becoming less socially acceptable in urban areas” (Otorohanga District Council, 2021).
	South Waikato District Council	Investigating the use of alternatives (Soil and Health Association, n.d.).
	Taupo District Council	Glyphosate is used, no evidence of considering alternatives.
	Thames-Coromandel District Council	Spraying in shopping areas is only done before 7am, and for residential areas spraying must be completed before 3am (Soil and Health Association, n.d.).

	Waikato District Council	Not considering spray-free options (Soil and Health Association, n.d.).
	Waikato Regional Council	Not responsible for maintaining areas used by the public (Soil and Health Association, n.d.).
	Waipa District Council	95% of roadside vegetation is controlled by mechanical mowing (Soil and Health Association, n.d.).
	Waitomo District Council	Uses Glyphosate. No indication of using alternatives (Soil and Health Association, n.d.).
Bay of Plenty	**Tauranga City Council**	Uses Glyphosate. Maintains 21 Glyphosate-free reserves (Tauranga City Council, n.d.)
	Rotorua Lakes Council	Petition against council to stop the use of Glyphosate (Dawson, 2016). Some natural sprays and mechanical control is used (Soil and Health Association, n.d.).
	Kawerau District Council	No information available. Probably uses Glyphosate.
	Opotiki District Council	Not considering alternatives. 85% of weed control is with herbicide (likely Glyphosate) and 15% is mechanical (Soil and Health Association, n.d.).
	Whakatane District Council	Following EPA guidelines (Soil and Health Association, n.d.).
	Western Bay of Plenty District Council	Mechanical methods main approach used in reserves (Soil and Health Association, n.d.).
	Bay of Plenty Regional Council	Not responsible for maintaining areas used by the public (Soil and Health Association, n.d.).
Gisborne	Gisborne District Council	Agrees with Morini (2018) that risk of exposure at carcinogenic levels is unlikely when following correct protocol (Cave, 2021).
Hawkes Bay	Central Hawkes Bay District Council	Some mechanical control in more public spaces (Soil and Health Association, n.d.).
	Hastings District Council	Glyphosate is used, no evidence of considering alternatives.
	Napier District Council	Uses Glyphosate. Does not use alternatives due to efficacy and notes that steam methods also damage soil biota (Soil and Health Association, n.d.).
	Wairoa District Council	20-30% of reserve weeds are controlled by mechanical means (Soil and Health Association, n.d.).
Taranaki	Taranaki Regional Council	Has been reducing Glyphosate use for 20 years (Taranaki Regional Council, 2021). Other options not viewed as financially viable.

	New Plymouth District Council	Alternatives are used where plausible but spray free areas have not been considered (Soil and Health Association, n.d.).
	South Taranaki District Council	Public areas are spot-sprayed only (Soil and Health Association, n.d.).
	Stratford District Council	Glyphosate is used, no evidence of considering alternatives.
Manawatu-Wanganui	Horizons Regional Council	Glyphosate is used, no evidence of considering alternatives and council not responsible for areas used by public (Soil and Health Association, n.d.).
	Horowhenua District Council	Glyphosate is used, no evidence of considering alternatives. High profile areas are hand weeded (Soil and Health Association, n.d.).
	Ruapehu District Council	Roadsides sprayed twice per year (Ruapehu District Council, 2023). Only uses Organic Biosafe in CBD areas (Soil and Health Association, n.d.).
	Palmerston North District Council	No information available. Likely uses Glyphosate.
	Manawatu District Council	Glyphosate is used, alternatives are not used or considered as of 2019 (Manawatū District Council, 2019). Herbicide sticker is used when spraying near aquatic ecosystems to improve adhesion to the sprayed plants (Manawatū District Council, 2019).
	Rangitikei District Council	Mechanical control used in 25-35% of situations (Soil and Health Association, n.d.).
	Tararua District Council	No information available. Likely uses Glyphosate.
	Whanganui District Council	Alternatives have not satisfied safety and practicality concerns (Soil and Health Association, n.d.).
Wellington	Carterton District Council	Uses Glyphosate. Alternatives would be too expensive, using lower concentration in mixture with other herbicides (Wairarapa Times-Age, 2018).
	Kapiti Coast District Council	Uses Glyphosate. Trials alternatives when they become available, finding that they tend to only kill emergent foliage with roots surviving to resprout (Kapiti Coast District Council, 2021).
	Greater Wellington Regional Council	Concerned that if Glyphosate was no longer available, the alternative herbicide options are more harmful, persist for longer, and more expensive/ineffective (Greater Wellington Regional Council, 2021).
	Hutt City Council	Glyphosate is used, no evidence of considering alternatives. Steam used infrequently but preparing to increase use if regulations on Glyphosate change (Soil and Health Association, n.d.)
	South Wairarapa District Council	Glyphosate is used, no evidence of considering alternatives.

	Masterton District Council	Uses Glyphosate. Exploring other options (Wairarapa Times-Age, 2018).
	Porirua City Council	Uses Glyphosate. Has considered changing to alternatives over the years but Glyphosate remains the most effective method so is continued in accordance with the stance of the EPA (Soil and Health Association, n.d.).
	Upper Hutt City Council	Glyphosate is used sparingly, and hand weeding is used where possible (Soil and Health Association, n.d.).
	Wellington City Council	Uses Glyphosate. No suitable alternatives available (Jones, 2021).
Nelson	Nelson City Council	Some mechanical control is done and mulching used to limit chemical use (Soil and Health Association, n.d.). Reviewing use of Glyphosate due to concerns raised by public (Jones, 2021).
Marlborough	Marlborough District Council	Calls to ban in 2020 (RNZ, 2020). Actions have been taken to reduce use in public spaces (Hart, 2022).
Tasman	Tasman District Council	No viable alternatives are as effective as Glyphosate (Soil and Health Association, n.d.).
Canterbury	Ashburton District Council	Glyphosate is used, no evidence of considering alternatives.
	Christchurch City Council	Halted Glyphosate use 6 years ago and in 2022, weed control costs had increased 4.5 times (NZ EPA, 2022).
	Environment Canterbury	Environment Canterbury does not manage areas frequented by the public (Soil and Health Association, n.d.).
	Hurunui District Council	Glyphosate is used, no evidence of considering alternatives.
	Kaikoura District Council	Glyphosate is used, no evidence of considering alternatives.
	Mackenzie District Council	No information available.
	Selwyn District Council	No information available.
	Timaru District Council	Alternatives to Glyphosate were considered but no action was taken (Timaru District Council, 2024).
	Waimakiriri District Council	Found that spraying of some drainage structures could be eliminated entirely by planting with native plants to outcompete weeds (Allen, 2020). For the majority of drains, mechanical control is implemented (Soil and Health Association, n.d.).
	Waimate District Council	No information available.

West Coast	Buller District Council	Glyphosate is used, no evidence of considering alternatives.
	Grey District Council	30% of footpaths maintained by mechanical methods (Soil and Health Association, n.d.).
	West Coast Regional Council	No information available.
	Westland District Council	No information available.
Otago	Central Otago District council	Glyphosate is used, no evidence of considering alternatives.
	Clutha District Council	Glyphosate is used, no evidence of considering alternatives.
	Dunedin City Council	An 8-7 vote from councillors determined Glyphosate will continue being used in the city (Scott, 2023).
	Otago Regional Council	Conducts an audit 2 weeks post-spraying to check for spray drift and effectiveness of application (Soil and Health Association, n.d.).
	Queenstown Lakes District Council	Conducting a review on options for minimising or eliminating the use of Glyphosate due 2025 (Queenstown Lakes District Council, 2022). Trialling natural fatty acid spray (Soil and Health Association, n.d.).
	Waitaki District Council	Tried alternatives which were not effective (NZ EPA, 2022). Has some no spray areas that are maintained mechanically (Soil and Health Association, n.d.).
Southland	Environment Southland	Mechanical Weed Control Carried out in drainage networks (Soil and Health Association, n.d.).
	Gore District Council	10-20% of amenity gardens managed by hand weeding (Soil and Health Association, n.d.).
	Invercargill City Council	Roadside spraying twice per year (Invercargill City Council, n.d.). Glyphosate is not used on roads or footpaths, only some use in parks (Soil and Health Association, n.d.).
	Southland District Council	Glyphosate is used, no evidence of considering alternatives.
Chatham Islands	Chatham Islands Council	Glyphosate is used, no evidence of considering alternatives.

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