An Investigation into Sustainable Cleaning Products: Dishwasher Detergents

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An Investigation into Sustainable Cleaning Products: Dishwasher Detergents

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ABSTRACT - 2

UBC is committed to sustainability and is moving toward becoming a zero-waste campus by reducing its waste, energy, and water consumption, as well as aligning its procurement practices to the values of sustainability. One recurring question received by UBC's Sustainability Engagement manager is the following: Which cleaning products are most sustainable? (Notably soaps, detergents, etc.) This report specifically targets dishwasher detergents and utilizes the triple bottom line approach to assess which dishwasher detergent would be best suited for students and staff at UBC. In order to accomplish this, only nearby stores such as Shoppers Drug Mart, Safeway, the UBC village, and Save on Foods were utilized to obtain dishwasher detergents and compare them against each other. Online documentation and research papers were also utilized to obtain information in regards to the ingredients found in the detergents, their effect on the environment, and the general public consensus on dishwasher detergents. The main points from the research were that phosphate is the main ingredient that no dishwasher detergent should have due to its harmful effect to the aquatic life, the Cascade brand was the cheapest in terms of cost per detergent load, and that although greener products tend to be less effective in cleaning dishes, companies are starting to identify ways to negate that problem. In a more practical manner, some of the detergents were compared against each other to see which product delivered the best output (in terms of cleaning grease, less remaining soap scum, etc). The results of the tests were that Cascade and Finish performed well during the test, and the no-name brand detergent failed the test since dishes were still dirty after washing. Another practical manner used to determine the best sustainable dishwasher detergent was through a survey completed by 24 UBC students asking them a variety of questions ranging from amount of money spent on dishwasher detergents per year to the preferred type of dishwasher detergent whether it be liquid, gel, or powder. The result of this survey was that most students, 54%, prefer and use the liquid dishwasher detergent and only a handful of students, 8% and 13%, prefer and use the powder dishwasher detergent respectively. It was also important to note that from the survey, 65% of students indicated that they did not care about the brand that created their dishwasher detergent. With the combination of all these methods and using the TBL to assess the dishwasher detergents, it was clear to see that the Cascade Rinse Away Residue (liquid/gel dishwasher detergent) is the most sustainable dishwasher detergent from the locations identified above.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS - 4

GLOSSARY - 5

Triple Bottom Line → This refers to an performance evaluation framework that includes social, environmental and economic aspects.
Phosphate → Refers to an additive found in detergents due to its cleaning ability as a water softener, before its use was banned because of environmental concerns.
Cost per Load → This refers to the cost of the amount of dishwasher detergent when every time a dishwasher is fully loaded and used.
Sustainability → The quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance:
Procurement → The act of procuring, or obtaining or getting by effort, care, or the use of special means
Polled (Poll)→ A sampling or collection of opinions on a subject, taken from either a selected or a random group of persons, as for the purpose of analysis.
Detergent → Any of a group of synthetic, organic, liquid or water-soluble cleaning agents that, unlike soap, are not prepared from fats and oils, are not inactivated by hard water, and have wetting-agent and emulsifying-agent properties
Soft Water→ Natural or treated water that does not contain a significant amount of dissolved minerals such as compounds of calcium or magnesium. It produces copious lather with a little amount of SOAP or detergent and does not form scales in boilers, heaters, and kettles. It is however linked to a higher incidence of heart (coronary) diseases
Hard Water → Water that has high mineral content (in contrast with "soft water"). Hard water is formed when water percolates through deposits of calcium and magnesium-containing minerals such as limestone, chalk and dolomite.Hard drinking water is generally not harmful to one's health,[1] but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers, and other equipment that handles water. In domestic settings, hard water is often indicated by a lack of suds formation when soap is agitated in water, and by the formation of limescale in kettles and water heaters

LIST OF ABBREVIATIONS - 6

TBL → Triple Bottom Line
UBC → University of British Columbia

1.0 Introduction - 7

Dishwasher detergent is very important because we use it to wash dishwares and we use these dishwares to serve food in daily life. The sustainability of dishwasher detergent play an essential role in sustainable development on campus. Our project focused on the environmental, social, and economic issues toward dishwasher detergent based on the triple bottom line method. In our project, we started the research first, then we conducted a questionnaire. After that, we analyzed the data collected from the questionnaire and chose three brands to test according to the questionnaire result. We performed 3 tests to see the efficiency of these dishwasher detergents. When the tests were accomplished, we compared those product based on their performance in price, environmental impact, and user preference. At the later stage of our project, we gathered all data from the previous stage as well as the results from the tests. We came up with a conclusion of the recommended product, and Cascade seemed to the best products in terms of price, environmental impact, and user preference.

2.0 METHODS - 8

2.1 Questionnaire - 8

In order to get valuable information about the usage of dishwasher detergent on campus, we designed a questionnaire that consisted of 7 questions about dishwasher detergent. The questions focused on detergent form, price, brand, and usage problem. The target groups of this questionnaire are UBC students and staffs. A google form (See Appendix A) of the questionnaire was posted on social network such as Facebook and Twitter to get the feedback from UBC students and staffs. 24 feedback was collected from UBC students and staffs. Even though it was a small group of people, we could still get useful information to be analyzed. The method of questionnaire was straight forward and results were clear to view.

2.2 Test - 8

According to the results we obtained from our questionnaire, we went to nearby stores such as shoppers and save on foods to buy different types and brands of dishwasher detergents. Among those products, there were powder ball, powder, gel, and liquid. To obtain the best comparison result, we bought Cascade, Finish, and no name in terms of brand in order to test the efficiency of those products.

The following pictures show the brands we bought for the test.

Figure 1: Finish Powerball

Figure 2: Cascade powder gel pack

Figure 3: No Brand Powder

After the purchase of the above dishwasher detergents, we used the standard dishwasher found in student residence to test the products. We decided to test the detergents against plastic containers whose material is made of polypropylene. We chose this because polypropylene is the most difficult dish material to wash in daily life. For each test, we put the same amount of dishware into the dishwasher, used the same type of container and poured 5 ml of pepper oil into it as an indicator for each test. We set the dishwasher to light wash with warm water, and kept this setting constant for each test. We conducted this test using Finish powerball, no-brand power pack, and cascade powder gel pack.

The test is shown below:

Figure 4: Finish powder ball before

Figure 5: Finish powder ball after

Figure 6: No name powder pack before

Figure 7: No name powder after Pack

Figure 8: Cascade powder gel pack before

Figure 9: Cascade powder gel pack after

2.3 Research - 11

During the project, we conducted online research as well as utilizing UBC library resources. For the online research, we searched commercial websites, online advertising, and Amazon customer reviews to get the valuable information about dishwasher detergent that we need for our project. Additionally, we fully used the UBC library resources, searching related journals, books, and academic articles to get scientific support for our project.

3.0 RESULTS - 12

This section of the report will discuss the results of the questionnaire, testing, and the research into detergents.

There are four types of detergent: powder detergents, powder tabs (also known as powder packs), liquid detergents, and liquid gel packs. The figure below shows the distribution of usage of the four types of detergents, as well as the students' preference of the different types. In general, students use liquid detergents and liquid gel packs, so we will aim to suggest a detergent that is one of these types. Within each type, it can be observed that student use powder or powder tab detergents, even if they prefer liquid or liquid gel packs, which suggests that affordability is an important consideration.

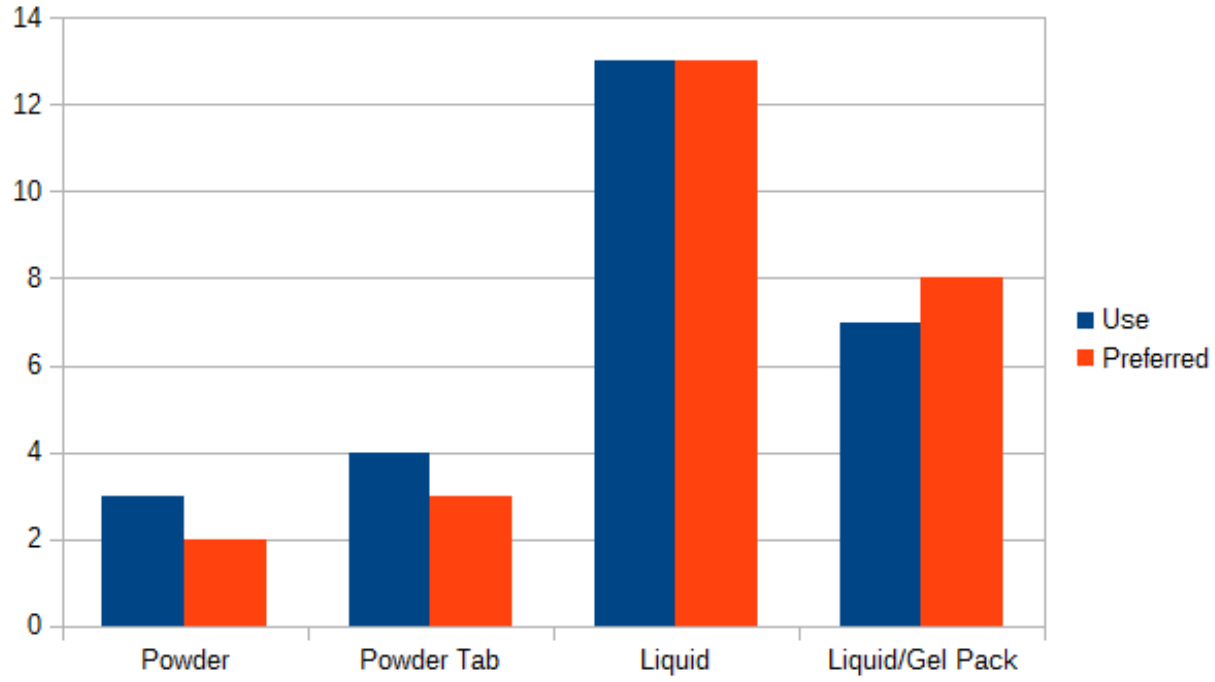

Figure 10: Types of detergents used vs. types of detergent preferred

For affordability, we asked students how much they spend on dishwashing detergent per year, on average. As shown in the figure below, there are two primary groups of students: those who spend between six to ten dollars, shown in red, and those who spend between 21 and 30 dollars, shown in green. The red section shows that students are looking for affordability, as we determined from the previous figure. However, the fact that there is also a large section of students in the green section suggests that a number of students are looking for effectiveness in their detergent. Ideally, the product we suggest as a result of this report should be both affordable and effective.

Figure 11: Yearly expenditure on detergents

In the questionnaire, students were polled about the types of brands that they use for their detergents. It was found that students generally use Cascade (in powder, liquid, and gel packs), a brandless lemon scented powder detergent found at the local convenience store, life dish pacs (powder tabs), oxiclean powder tabs, and finish lemon scented liquid gel packs. However, the questionnaire also asked students about their brand loyalty, whether they cared about which brand in particular they were buying. The figure below shows that the majority of students do not care about the particular brand they buy. This means that students should be receptive to the detergent that we suggest, even if it is not a brand that they typically purchase.

Figure 12: Brand Loyalty

In order to compare the detergents against each other to determine the most effective one, they must all be tested against the same type of contaminant. To do this, we asked students which issue they found to be the most problematic for their dishwasher. The most commonly reported problem was heavy grease, followed by soap scum, foam spillover, and the detergent being hard to be dissolved. Due to this, we decided to conduct our tests of the different detergents against heavy grease/oil, as explained in the test section of the report. The results of the test were that Cascade and Finish brands were the most effective at removing the pepper oil, with the no-name brand being ineffective. The cascade and finish brands will be investigated further in a TBL assessment.

4.0 TRIPLE BOTTOM LINE - 15

4.1 TBL - SOCIAL - 15

There are several social implications to consider when recommending a dishwasher detergent to students and staff. How well does the product clean? What kind of detergent to students and staff prefer to use? How easy is it to find and buy the product? All of these are important questions to consider.

The questionnaire results showed that the most common issue with detergents was cleaning heavy grease off of dishes. Therefore, the test in section 2.2 focused on testing how well each product cleaned the grease. Section 2.2 shows that the Finish Powerball and the Cascade powder gel pack are the most effective cleaners at cutting grease off of dishes.

As seen below in Figure 13 from the results of the questionnaire, most students prefer either liquid or liquid/gel pack detergents. Because of this, we will focus mainly on these types of detergents. We will also only consider products which are available to buy on campus.

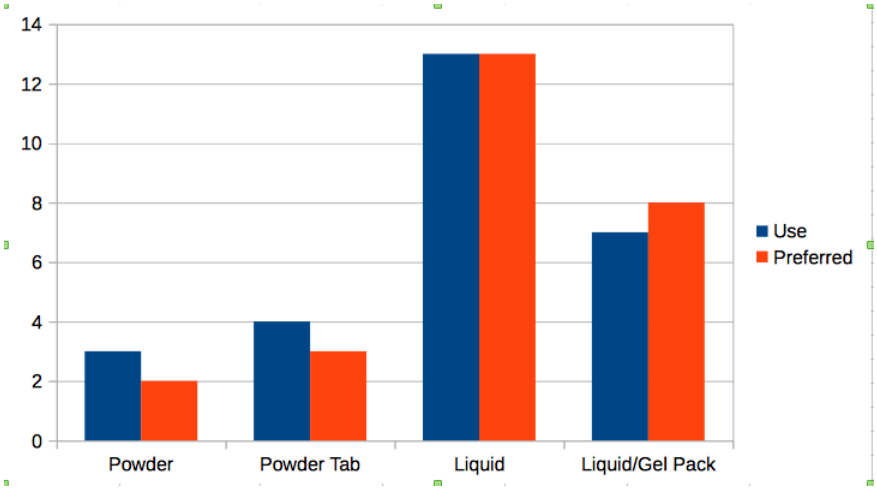

Figure 13: Survey Results #1

Another thing to consider is the ingredient list of the detergents. The environmental impact of the ingredients will be discussed in section 4.3, but it is also important to check if any of the ingredients may be harmful or irritating if touched or swallowed directly. Indeed, all of the detergents in question are considered minor irritants if they come into contact with the skin or the eyes. None however are more dangerous than the others.

Based on user preference, cleaning efficiency, and how easily the product is available, it seems that both the Finish Powerball and the Cascade powder gel pack are the best options from a socially conscious standpoint.

4.2 TBL - ECONOMICAL - 16

Prices of dishwasher detergent in the market are usually indicative of the total price of a whole pack of detergent. However, this price is not able to offer a direct indicator of the price that is paid for detergent every time when dishwasher is fully loaded. In this economic aspect of TBL, the unit price of dishwasher detergent was focused. Unit price of dishwasher detergent refers to the price that dishwasher detergent cost every time a dishwasher is fully loaded. To get to final data, some parameters are taken into account. As for dishwasher on its own, the different model has different detergent dispenser and water amount. Because this project is focusing on dishwasher detergent, we used one dishwasher to minimize the influence from the dishwasher on the data. Based on the dishwashing procedure of a dishwasher, the water needs to be softened first. In this case, water hardness is one parameter that needs to be taken into consideration. According to water hardness in Vancouver, the water is soft water which requires less dishwasher detergent.Another parameter is dishes soiled level which can be controlled. It is reasonable to assume that the dishes that are put into dishwashers are normally soiled. Based on this assumption and water hardness level, for powder and liquid detergent, around 40ml (1.5oz) of detergent are required per load and for gel pack, one pack is sufficient for every time using dishwashers. According to this amount and the price of dishwasher detergent in market, the following data were approached.

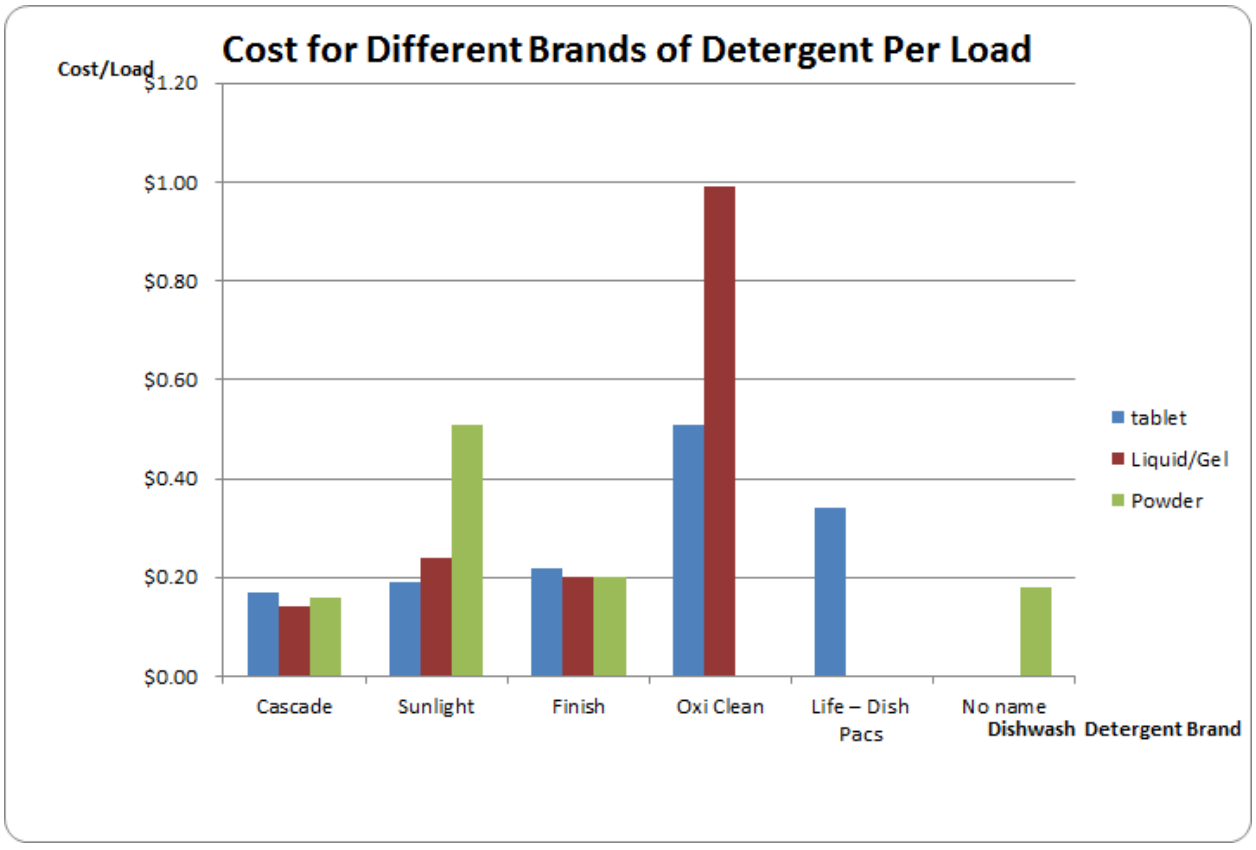

Figure 14: Survey Results #2

Three price ranges are shown in the data above. All forms of cascade, finish, no name brand and tablet, liquid form of sunlight brand are in the low price range. Tablet forms of life, oxi clean brand as well as powder form of sunlight brand are in medium price range. The liquid form of oxi clean falls into the high price range. This data basically matches our survey results that if the price is lower, more people would like to purchase it. After knowing the unit price of the different dishwashers, another raised issue is which detergent is more effective for cleaning dishes based on its price. A survey was done to random students in UBC. Based on the survey, from all brands and forms of detergent that are approachable around campus, cascade gel pack, finish liquid form, finish gel pack and no name power form were tested. The test result revealed that the cascade brand has strong power to clean the soiled dishes and this result, and combining with the economic aspect of TBL, it is reasonable to suggest that cascade is a good brand to choose.

4.3 TBL - ENVIRONMENTAL - 17

For this section of the investigation, a table was created which contains the dishwasher detergent, its ingredients, and the effect that specific ingredient has on the environment (APPENDIX B). In order to obtain the ingredients of the dishwasher ingredients, the company website for the detergents were visited or the ingredients were identified on the back label of the detergent (No Name brand and Life Brand). It was quite strange that the No Name Brand and the Life Brand did not have their ingredient list online, so it was quite easy to assume (and rightly so) that the ingredients they are using to create their products would not be very environmentally friendly. Looking at the ingredients list, it was important to note that none of the dishwasher detergents had phosphate, a fish killing product, and that was a very good thing since the early research pointed out that phosphate in dishwasher detergents is a major red flag. Phosphate is a major red flag because it exponentially accelerates the growth of algae in the sea and with that growth comes a lack of oxygen for the aquatic life. Unfortunately, some of the products do have dangerous ingredients such as sulfuric acid, sodium percarbonate, sodium silicate and sodium Dicholoroisocyanurate. As can be seen from Appendix B, these four products are especially dangerous because they are toxic to aquatic life. Obviously, it depends on the amount inserted into the environment but it does display that it is possible for the products to harm the environment.

Looking at APPENDIX B, one will notice that the only products without a “dangerous” ingredient are the products associated with cascade. From this it can be concluded that in terms of the TBL - Environmental outlook, the cascade brand is the clear winner.

5.0 CONCLUSION AND RECOMMENDATIONS - 18

The purpose of this report was to determine the best dishwasher detergent under the triple bottom line umbrella. From our research through surveys, research papers, experimental tests, etc., the most sustainable dishwasher detergent product came out to be the liquid/gel pack dishwasher detergent from Cascade as identified in figure 2. Looking back at the research paper, the cascade brand checked all the right boxes in all aspects of the triple bottom line (social, environmental, and economical) and the company is also a well known brand as well. Due to its close proximity to students, it will definitely be a good pick for students aiming to be more sustainable in this aspect of life.

For recommendations, it would be better to expand the number of detergents or even expand the number of stores visited to obtain dishwasher detergents. That way, a bigger variety of detergents can be researched and identified as the best under the triple bottom line umbrella. The survey utilized for this project can also be given to students outside UBC and given to citizens in the greater Vancouver area in order to obtain a better representation of people opinions towards dishwasher detergents.

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APPENDICES A - X - 22

Appendix A - Survey - 22

Form Title

How much money do you spend on dishwasher detergent each year?

- $0-5
- $6-10
- $11-20
- $21-30
- >$30

What type of dishwasher detergent do you use?

- Powder tab
- Liquid
- Gel pack
- Powder

Do you buy a particular dishwasher all the time?

- Yes, I buy the same product all the time.
- No, I don't care about the type or brand.

Which is the most comfortable form for using?

- Power tab
- Liquid
- Powder
- Gel pack

What is the most problems when using dishwasher detergent?

- Too much foam spill out of the dishwasher.
- Detergent is hard to be dissolved.
- Detergent remains on plates.
- Heavy grease.
- Others(please indicate)

Which type of dishwasher detergent is better to use?

- Powder tab
- Liquid
- Powder
- Gel pack

Which brand of dishwasher do you use right now?

Appendix B - Dishwasher Detergent Ingredient List - 23

Detergent Brand		Type
Cascade	Cascade - Rinse away residues	Powder
No name	Lemon scent diswasher detergent	Powder
Life	Dish Pacs	Packs - Powder
Finish	Finish - Lemon Scent	Gel/Liquid
Cascade	Cascade - Rinse away residues	Gel/Liquid
Oxi Clean	Dishwasher detergent - Extrement power crystals	Packs - Powder

Detergent	Ingredients	Function	Environmental effect
Cascade - Rinse away residues - Powder	Citric Acid	Complexing/Sequesting agent	Citric acid is naturally found in food and water and readily biodegrades in the environment, so no significant negative effects are expected
	Alcohol Alkoxylates	wetting agent	Not toxic, no carcinogenicity, high probability not acutely harmful to aquatic life
	Silica	absorbant	
	Acid Blue 182	colorant	Does not contribute to ecotoxicity. Not listed as toxic towards humans as well
	Perfumes	Fragrance	
Cascade - Rinse away residues - Liquid	Alcohol Alkoxylates	Wetting agent	
	Dipropylene Glycol	Wetting agent	Dipropylene glycol has a low vapor pressure and very little will evaporate to the air. However, because it is highly soluble in water and unlikely to bind to soil or sediment, once dipropylene glycol is introduced to water, the substance will tend to remain

			dissolved in water. Because dipropylene glycol is readily biodegradable, it will be efficiently removed in wastewater-treatment facilities, and will be ultimately destroyed by bacteria present in soil, surface waters, and sediments
	Trideceth-n	Wetting agent	
	Water	Diluent	
	Glycerine	Processing aid	Glycerine has no harmful impact on the environment due to a massive release or spill. In water, it does not appear to have any effect other than an oxygen demand arising from biodegradation which occurs at a moderate rate.26 Aquatic toxicity as measured by TLm96, defined as the concentration that will kill 50% of the exposed organisms in 96 hours, is over 1000 mg/L.27 a level which is insignificant.
	Acid Blue 182	Colorant	Does not contribute to ecotoxicity. Not listed as toxic towards humans as well
Finish - Lemon Scent	Sodium Silicate	Complexing/Sequestering Agent	Slightly corrosive, could possibly harm aquatic life (very unlikely)
	2-Propenoic acid, telomer with sodium hydrogen sulfite, sodium salt	Polymer	
	Acrylic Acid Homopolymer	Thickener	No significant environmental effect
	Potassium Hydroxide	pH Adjuster	
	Sodium Hypochlorite	Bleaching Agent	Very toxic to organic organisms. Poured into drain of the household use will react with organic matter and will be

			removed before reaching the environment
	Phosphonobutanetricarboxylic Acid	Complexing/Sequestering Agent	
	Zinc Sulfate Hexahydrate	Preservative	
	Fragrance / Parfum	Fragrance	
	Sulfuric Acid	Organic - Acid	It dissolves when mixed with water. It has moderate acute (short-term) toxicity on aquatic life. Sulfuric acid is very corrosive and would badly burn any plants, birds or land animals exposed to it. It has moderate chronic (long-term) toxicity to aquatic life.
	CI Pigment Blue 29	Colorant	
Oxi Clean	Trade Secret		
	Sodium Carbonate		As indicated before, the emission of sodium carbonate to the aquatic environment will increase the pH of the water. Depends on the buffer of the water as well therefore could potentially be harmful. Negligible effect on the carbon chemistry of aquatic ecosystems.
	Sodium Percarbonate		Sodium percarbonate is not persistent in the environment and readily dissociates to sodium carbonate and hydrogen peroxide which will subsequently decompose to water and oxygen when exposed to soil, sediment and surface or groundwater. Sodium percarbonate is toxic to certain aquatic organisms, in particular algae, crustaceans and microorganisms. This is linked to the presence of hydrogen peroxide

	Silicone Dioxide, Amorphous		None
	Alcohol Ethoxylate		Alcohol Ethoxylates (AE) are readily biodegradable under aerobic and anaerobic conditions. Total measured removal rates in wastewater treatment plants vary from 99.6 to 99.9%. Toxicity to aquatic organisms, measured by EC50, ranges from very toxic (<1 mg/L) to harmful (between 10 and 100 mg/L)
	Sodium polycarboxylate	avoid incrustation and soil redeposition	Not pose a risk to the environment
	Amylase, alpha		
No Name - Lemon Scent dishwasher det	Sodium Carbonate		As indicated before, the emission of sodium carbonate to the aquatic environment will increase the pH of the water. Depends on the buffer of the water as well therefore could potentially be harmful. Negligible effect on the carbon chemistry of aquatic ecosystems.
	Sodium Silicate		
	Sodium Dichloroisocyanurate		This pesticide is toxic to fish and aquatic organisms.
Life - dish pcs	Sodium Carbonate		As indicated before, the emission of sodium carbonate to the aquatic environment will increase the pH of the water. Depends on the buffer of the water as well therefore could potentially be harmful. Negligible effect on the carbon chemistry of aquatic ecosystems.
	Sodium Percarbonate		Sodium percarbonate is not persistent in the environment and readily dissociates to sodium

			carbonate and hydrogen peroxide which will subsequently decompose to water and oxygen when exposed to soil, sediment and surface or groundwater. Sodium percarbonate is toxic to certain aquatic organisms, in particular algae, crustaceans and microorganisms. This is linked to the presence of hydrogen peroxide
	Enzymes		Toxity to aquatic life is extremely low