Tenere Life Cycle Impact Analysis

Final Report & Methodology

Updated April 12, 2021

The report below provides the methodology, results, and data comprising Tenere's preliminary Life Cycle Impact Analysis, conducted by GreenStep Solutions.

Executive Summary

The report below outlines the findings and recommendations from Tenere's 2021 Life Cycle Impact Analysis (LCA). The primary objective of this LCA project was to measure key environmental impacts of Tenere's activewear garments across its supply chain, and generate meaningful data on the impact of its garments so that the Tenere team can use the results (a) to communicate its footprint to its customers, (b) as an initial basis for which it can use to continue to reduce its impact within its existing supply chain, and (c) to calculate its footprint for emissions, water, and waste so it can offset its existing footprint correctly. The garments assessed included Tenere's Transit Short, Transit Liner Short; Eclipse legging and bike short, and Astral legging and bike short.

Tenere is a new garment company based in the USA that launched on April 6, 2021. Due to financial, economic, and COVID-19 related constraints, the initial production run was flown to the southern California warehouse; Tenere intends for its second and future production runs to be transported by ocean freight. Because of this, GreenStep has shown two separate LCA outputs: one reflecting the initial production run using air transport (From garment manufacturing to warehouse) and one reflecting what the projected results will be once ocean freight is the primary transport mechanism from garment manufacturing to warehouse (initial output results below).

For the purposes of this analysis, and to keep the project specific to Tenere's sustainability mission, the focus was on areas of environmental impact that Tenere believes are of primary importance in a global effort to build a more sustainable future: global warming (carbon emissions), water consumption, and waste.

Tenere's overall impact on a per-garment basis is demonstrated in the below overview tables, and further analysis is provided in the following report.

Initial Production Run - 100% air shipment (garment to warehouse)				
Garment	**Fabric**	**Total CO2e (kg)**	**Total Water (L)**	**Total Waste (kg)**
Transit Short	36GG Knit, Woven Fabric	9.26	232.12	0.28
Transit Liner Short	36GG Knit, Woven Fabric	13.71	241.39	0.45
Eclipse Legging	36GG Knit Fabric	8.33	122.84	0.38

Eclipse Bike Short	36GG Knit Fabric	6.25	118.53	0.30
Astral Legging	28GG Knit Fabric	9.24	124.72	0.42
Astral Bike Short	28GG Knit Fabric	6.93	119.85	0.33

Initial production run impacts across all of Tenere's activewear garments using air transport
(Water consumption includes an assumed consumer use phase of 50 washes over the life span of one garment)

Second and Future Runs - 100% ocean freight transport (garment to warehouse)				
Garment	**Fabric**	**Total CO2e (kg)**	**Total Water (L)**	**Total Waste (kg)**
Transit Short	36GG Knit, Woven Fabric	6.23	231.41	0.28
Transit Liner Short	36GG Knit, Woven Fabric	8.07	240.08	0.45
Eclipse Legging	36GG Knit Fabric	3.69	121.76	0.38
Eclipse Bike Short	36GG Knit Fabric	2.82	117.73	0.30
Astral Legging	28GG Knit Fabric	4.06	123.51	0.42
Astral Bike Short	28GG Knit Fabric	3.12	118.97	0.33

Projected future impacts from transitioning to 100% ocean freight transport *(Water consumption includes an assumed consumer use phase of 50 washes over the life span of one garment)*

Tenere Management Foreword

The following comments have been provided by Tenere management.

Tenere is a new premium activewear brand that is deeply rooted in sustainability and radical-transparency. Our sustainability mission consists of four core components: Environmental Impact, Ethical Sourcing, Social Advancement, and Principled Corporate Governance. Our other brand pillars include Activism - “everyone is an activist; every act, no matter how small, is a meaningful contribution toward a better future”; and Wellness - “in order to help others, you must also take care of your own body and mind.”

Our primary objective of this LCA project was to to hire a reputable and reliable third party in GreenStep Solutions to help us measure the areas of environmental impact within our supply chain that we believe are of primary importance in a collaborative global effort to build a more sustainable future: (1) global warming/climate change (carbon emissions), (2) water consumption, and (3) waste. Quantifying and generating meaningful data on the impact of our supply chain is important because it will (a) help us communicate our footprint to our customers, (b) act as an initial basis for which we can use to continue to reduce our impact within our existing supply chain, and (c) help us calculate our existing footprint for emissions, water, and waste so that we can offset it accurately, to be carbon, waster, and plastic neutral.

Typically, businesses conduct life cycle assessments after their business has already begun generating revenues and after several production runs, or after many years of being in business. We are a brand new company that launched on April 6th, 2021. **We are imperfect. Some of our data is imperfect. Some of our assumptions are imperfect. Some of our processes are imperfect. We are trying to show you, our customer, that we are well-intentioned and want to do right by you and work together with you toward achieving a more sustainable future for all.**

There are several limitations, exclusions, and areas where we need to improve within this analysis that we wanted to point out:

1. Air Transport: We used air transport both (A) between our fabric supplier and and our cut/sew factory partner and (B) from cut/sew factory partner to our warehouse in California. This led to more carbon emissions than if we had used ocean

transport. We needed to accelerate our launch timeline due to financial, economic, and COVID-19 related constraints. That said, we fully intend for our second and future production runs to be transported by ocean freight.

2. Trims & Components: This LCA excludes the impact of our trims and components (e.g. zippers, zipper pulls, seam tape, bonding adhesives, sewing thread, drawcords, and elastic waistbands). While these trims and components represent a relatively small portion of our footprint, we still hope to include this data in future iterations of our LCA.
3. Third Party Data: Due to COVID-19 restrictions, our management team was not able to hand observe, measure, and audit the full impact data that we received from our suppliers. Therefore, in many instances within this analysis, we had to rely on unaudited supplier provided inputs, the HIGG Materials Sustainability Index and peer-reviewed secondary research and data instead.
4. Fossil-Fuel Energy: Most of our supply chain uses energy generated from burning fossil-fuels, which contributes to global warming/climate change. We have already started connecting and making partnerships with factory partners that use renewable energy.
5. Microfiber Fragmentation: One of the major sustainability issues related to making garments using synthetic material inputs, is microfiber fragmentation. When you wear or wash these garments, whether they were recycled or not, they release tiny micro-particles of plastic into the air and into our oceans causing severe pollution and damage to both our ecosystem and to humans unintentionally breathing in or consuming these particles. To minimize this impact Tenere has a strict commitment to (a) avoid using short length spun synthetic fibers, (b) develop textiles made of yarns that have a denier per filament greater than 1, (c) minimize mechanical abrasion of fabric surfaces using techniques such as brushing, sanding, and peaching, which intentionally break fibres and promote earlier fragmentation. Over the years our team has been actively involved in research to minimize fiber fragmentation issues and will continue to heavily invest resources towards this problem.

Tenere's foundational brand ethos strongly reflects the value it places on (i) protecting the environment, (ii) providing dignified, fair, and safe work to its employees, workers, and contractors and (iii) progressing and advancing our society and its people toward a sustainable future.

If you have any questions, comments, challenges, or criticisms on this analysis or our intentions, please email us at info@tenere.eco. We look forward to building a better future together with you!

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Introduction

Tenere is an activewear brand with its first product line including leggings and shorts that are composed of 100% GRS-certified[1] recycled materials. This report outlines the findings and recommendations from Tenere's Life Cycle Impact Analysis (LCA) for its line of activewear garments. Because Tenere is a new company that launched on April 6, 2021, this LCA is considered preliminary. As Tenere grows its customer base and scales the production of its activewear, it will generate more primary data for its garments; those data, added to this preliminary dataset, will result in a more robust LCA.

The key objectives of this LCA were to:

- Measure pre-identified environmental impacts of Tenere's activewear garments across its supply chain.
- Establish a baseline for Tenere's activewear garments in terms of CO2e emissions, water consumption, and waste as they work to launch their company.
- Produce a report that identifies carbon, water, and waste impact of an agreed-upon list of garments (see full list in "Products") as well as a spreadsheet to calculate these values.

Unique to this LCA is the inclusion of separate transport mechanisms between Tenere's garment manufacturer in Indonesia and its warehouse in Southern California: both international air and ocean freight were modeled. This was done to assess the difference in impacts from Tenere's initial production run - the timeline for which was expedited to ensure garments were available for the April 6 launch - and its second and future production runs, once the company is established.

For the purposes of this report, the terms Life Cycle Impact Analysis and Life Cycle Assessment (LCA) are assumed to refer to the same process and are used interchangeably.

[1] *GreenStep has not verified this certification, this information has been provided by Tenere.*

What sets Tenere apart?

Tenere has highlighted to GreenStep several of the steps it has taken to differentiate itself from its competitors. Those factors that positively impacted Tenere's LCA include:

- Use of recycled fibres in its garments, including elastane. Recycled elastane is an emerging textile choice for garment manufacturing. The process utilizes defective elastane material (pre-consumer recycled) to be collected and melted down, before being spun into new yarn.
- Use of recycled packaging including box cartons and polybags for shipment and transport to warehouse and recycled tissue paper, labels, and mailers for shipment from warehouse to customer.

Further, Tenere has established partnerships with certification programs and non-profit organizations who align with their mission, and undertaken additional measures, which have the potential to create positive impacts but that have not been captured or verified through this LCA. These include:

- Commitment to three core practices: sustainability, activism, and wellness
- Commitment to radical-transparency -- specifically highlighting both its open-source supply chain and its web-based transparency experience via QR code sharing specific details around certifications, a component-level sourcing matrix, environmental footprint and strategy to reduce and offset, ethical worker pay/detail/policies, a full chronological product journey through our supply chain, and finally – programs for garment's end of life.
- Standard 100 by Oeko-Tex-certified (application under review)
- Use of 100% Global Recycle Standard (GRS)-certified recycled yarns in its garments
- Use of recycled components such as zippers, zipper pulls, sewing thread, drawcords, and elastic waistbands.[2]
- All fabrics and chemistries in Tenere's garments are bluesign® approved. bluesign® SYSTEM is an independent verifier of textiles whose "Blue Way" system provides safer and more sustainable environments for people to live and work in.[3]

[2] *These trims have not been included in the LCA.*

[3] *This information has been provided by Tenere and has not been verified by GreenStep.*

- Compliance with the Zero Discharge of Hazardous Chemicals' (ZDHC) Manufacturing Restricted Substances List (MRSL 2.0)[4]
- Garment manufacturer partnership and compliance with the Fair Labor Association.
- Partnership with Textile Exchange, a global non-profit whose mission is to positively impact the climate through accelerating the use of preferred materials across the global textile industry, and whose membership base represents leading brands, retailers, and suppliers.
- Partnership with the Outdoor Industry Association, whose mission is to work collaboratively with its members on policy, sustainability, participation, education, and research all pertaining to outdoor recreation.
- Partnership with the Climate Action Corps, a division of the Outdoor Industry Association, whose members commit to measure and report on their greenhouse gas emissions with the ultimate goal of reducing emissions.
- Partnerships with and donations to social and environmental justice organizations such as Eden Reforestation Projects and 1% for the Planet.
- Commitment to progressing towards achieving the 17 United Nations Sustainable Development Goals, even those that don't directly correlate to the operations of their business.
- Manifesto on the company website explaining why and how it is not completely sustainable and shares a roadmap for its commitments through 2025.
- A conversation board on its website where customers can ask questions, challenge, or speak for or against the company's sustainability practices.
- Sustainability programs including TeneRE:wear (encourages returning used wearable garments for resale or donation), TeneRE:pair (encourages customers to have some of their fixable products repaired by us), TeneRE:cycle (encourages repurposing or downcycling), and TeneRE:duce (Tenere's program for the reduction and offset of its environmental footprint).

Goal & Scope

The goal and scope of Tenere's preliminary life cycle assessment was to measure key environmental impacts of Tenere's activewear garments across its supply chain. To achieve this goal, GreenStep gathered data from the HIGG Materials Sustainability Index, which uses primary and peer-reviewed secondary research data informed by industry partners

[4] *Eutrophication/toxicity was not included in the LCA*

and other LCA datasets (including GaBi, ecoinvent, and Quantis), and from Tenere, who gathered data from their Tier 1-4 supply chain partners. This data fed a custom-built calculator that illustrates, on a per-garment basis, impacts from carbon emissions, water consumption, and solid waste.

This LCA was created using initial production run data available from Tenere and is preliminary in its impact assessment. As more data comes online, it will only add to the robustness of Tenere's LCA outputs. The garments that GreenStep sought to analyze are as follows:

Products

- Transit Short
- Transit Liner Short
- Eclipse Legging
- Eclipse Bike Short
- Astral Legging
- Astral Bike Short

Formulations

The formulation for Tenere's garments varies according to garment type, but all are formulated using recycled fibres including:

- The Transit shorts product line is comprised of a blend of fibres including recycled nylon, rPET, and recycled elastane
- The Eclipse product line is comprised of recycled nylon and recycled elastane
- The Astral product line is comprised of a blend of fibres including recycled nylon, rPET, and recycled elastane

Parameters

Using the data collected, GreenStep calculated carbon, water, and waste impacts of each garment based upon the following key parameters:

- Style
- Weight
- Composition

- Manufacturing process
- Packaging materials

Environmental Inputs & Outputs

A full LCA typically identifies potential impacts from global warming, acidification, eutrophication, ozone depletion, photochemical ozone, and primary energy; however, for the purposes of this study, the focus was on the environmental aspects that Tenere believes are of primary importance in a global effort to build a more sustainable future: global warming (carbon emissions), water consumption, and waste created. To that end, the following environmental inputs and outputs were assessed:

- Inputs: raw materials, water, energy, waste
- Outputs: kg CO2e (carbon dioxide equivalent), litres of water consumption, kg waste disposal/recycling

System Boundary

In order to establish a scope boundary for this methodology, the team at GreenStep met with Tenere to identify the garments to be assessed, along with all raw material extraction and processing inputs, garment manufacturing details, transportation mechanisms, consumer use-phase information, and end-of-life estimates. In combination with primary data obtained from Tenere's Tier 1-4 supply chain partners, GreenStep also conducted secondary research to gather industry standards, relevant coefficients, and background primers on the various processes outlined below.

Following data collection, GreenStep built a LCA calculator that would showcase differences in impact across all garment lines, from "cradle" to "grave." The primary output of the calculator is a series of values that rank the impact of each Tenere product in the areas of carbon dioxide emissions, water consumption, and waste. The "cradle" for each garment began with the collection of raw material waste to then be cleaned, melted down, and extruded into yarn and continued on from there, with the "grave" being the end-of-life stage of each garment (i.e., landfill, recycle, donate).

The system boundary was defined as follows:

Processes included:

- Raw material recycling and transit to the yarn manufacturers

    - Recycled nylon, recycled PET bottles, recycled elastane
    - Raw material sorting, cleaning, and pre-processing
- Yarn manufacturing
    - Extrusion, drawing, and texturing
- Textile manufacturing
    - Knitting, weaving
- Dyeing (prep and colouring)
    - Fabric dyeing
    - Yarn dyeing
    - Setting
- Garment manufacturing
    - Cutting, printing, sewing, bonding, and packaging
- Transportation from cradle to warehouse “gate”
- Consumer Use Phase and End-of-Life Scenarios (“grave”)

Processes not included

- Trims

Functional Units

- 1 Tenere garment (active shorts; biker shorts; leggings)

Methodology

GreenStep has conducted a cradle-to-grave life cycle impact analysis (LCA) for each of Tenere’s six activewear garments and associated fabric blends. This LCA consists of the following phases: recycled feedstock collection, processing, yarn manufacturing, fabric formulation, dyeing and finishing, garment manufacturing, transportation, packaging, warehousing, consumer care, and end of life.

Tenere provided GreenStep with the following data:

- Product name and style code
- Product material composition and percentage of each
- Weight in grams per square metre (gsm) for each material
- Manufacturing processes and wastage from these processes
- Locations of manufacturing for each raw material and input

- Locations of product manufacturing
- Locations of and means of distribution

The Tenere garments were assessed using the same manufacturing, transportation, warehousing, and end-of-life system boundaries and assumptions. Each garment was identified by its finished weight (kg) - *calculated based on material per garment (in square meters), its specific fabric blend, and the weight of the full fabric bolt* - and passed through each stage of the LCA as a stand-alone unit of measure.

In the case of Tenere's "Transit Short" and "Transit Liner Short," because these garments included multiple materials, they entered the "garment phase" split out into their component parts. In further LCA stages (cut/sew, transportation, and waste) these components have been combined to illustrate total impacts per entire garment. As well, the "Final Output" depicts total impacts per garment.

LCA Stages:

1. Yarn/Fabric Formulation
    a. Recycled feedstock collection, yarn manufacturing, knitting, weaving, dyeing, and finishing of the fabrics
2. Cut/Sew
    a. Cutting, sewing, bonding, and finishing of final garment
3. Transportation[5]
    a. Transportation was defined by the approximate distance travelled (km) between all processing, manufacturing, and warehousing locations; the mode of transport (either road, ocean freight, or international air); and divided into upstream and downstream emissions.
    b. Road:
        i. Truck between raw material extraction/pre-processing- and yarn manufacturing facilities, where applicable (Taiwan)
        ii. Truck between yarn manufacturing and fabric mills (Taiwan)
        iii. Truck between fabric mills and dye houses, where applicable (Taiwan)
    c. Ocean Freight:
        i. Between pre-processing (Germany) and yarn formation facilities (Taiwan)

[5] *In the "Transportation" tab of the LCA, data are divided into "upstream" emissions and downstream emissions. Upstream is defined as any processes up to and including garment manufacturing, while downstream emissions include the point at which a fully-formed garment leaves the garment manufacturer and begins its journey to the Tenere warehouse.*

   d. International Air[6]:
      i. Between fabric manufacturing (Taiwan) and garment manufacturing (Indonesia)
      ii. Between garment manufacturer (Indonesia) and warehouse (southern California)
4. Packaging[7]
   a. 100% recycled cardboard ship box, 100% recycled polyurethane liner, 100% recycled tissue paper per garment, 100% recycled paper mailers (1 per garment)
   b. 50 garments packed per ship box
5. Consumer Care
   a. For Tenere's products, the stated care instructions include machine wash cold and hang dry. GreenStep assumed these as the baseline consumer care instructions, and modeled impacts off of the Transit Liner Short. Number of washes was estimated at 50 over the lifetime of the garment.
6. Warehousing
   a. Warehouse CO2e and water impacts were assumed to be the same across all garments. Impacts were calculated using garment pack # (50), ship box volume, approximate LA warehouse energy data (from the US Energy Information Administration, see references), and an assumed residency time of 3 months (0.25 or 25%).
7. Waste
   a. Garment end-of-life was assumed to consist of 15% of the garments being recycled (as per EPA 2018 data, see references) with the remaining 85% of garments being landfilled.
   b. Packaging[8] end-of life was assumed to consist of 40% of materials being recycled with the remaining 60% landfilled

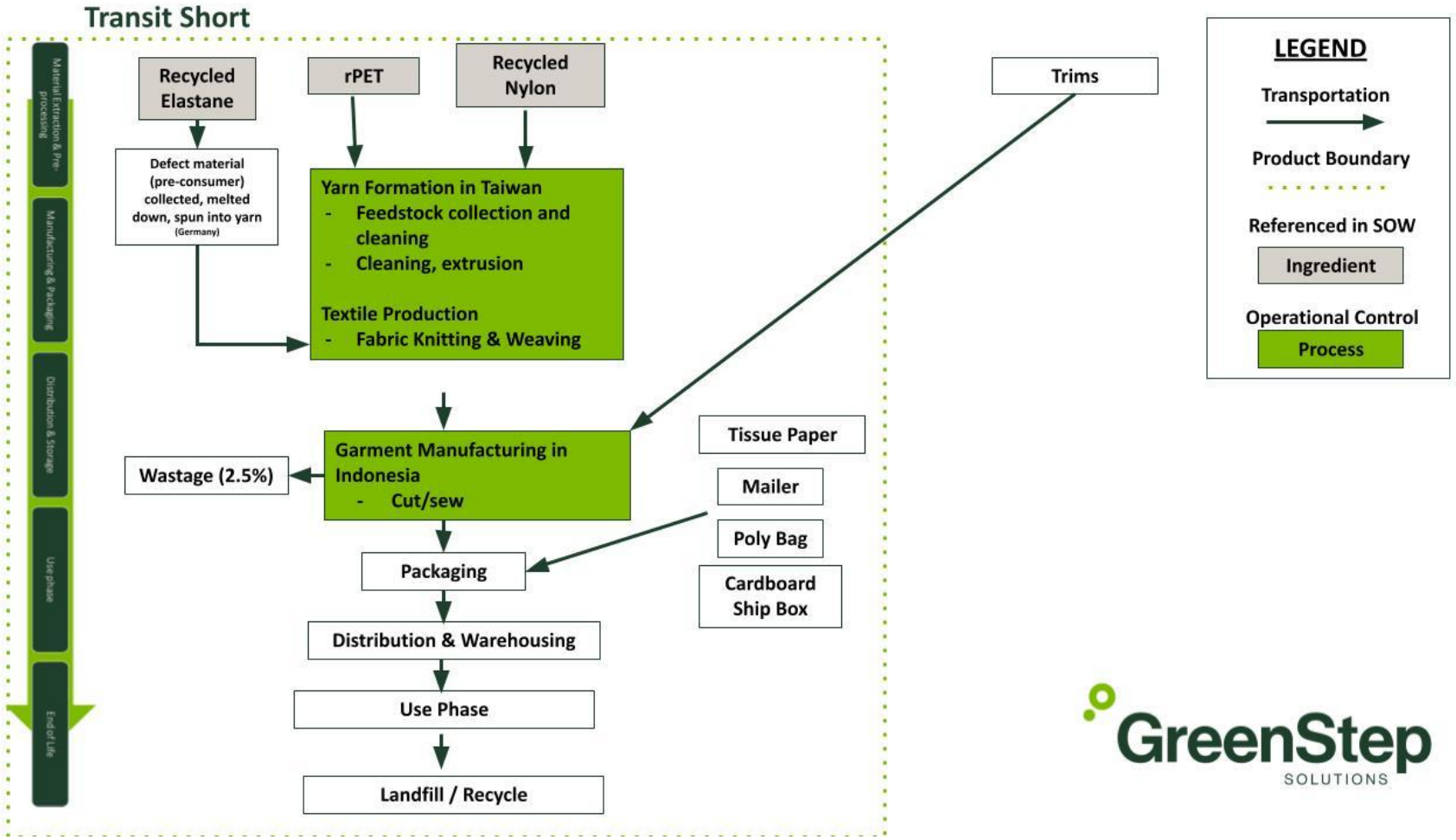
[6] *This LCA was based upon initial, preliminary production run data. Because Tenere was working to achieve a launch date of April 6, 2021, certain logistics had to be expedited, including transportation of fabrics to garment manufacturers, and from garment manufacturing to the final warehouse. This initial production run utilized 100% international air for these transportation routes. In future, these transportation routes will be covered by ocean freight.*

[7] *Poly liner was modeled using data for LDPE bag production as this plastic (LDPE) is most commonly associated with plastic bags, and more data was available.*

[8] *For the purposes of this LCA, GreenStep calculated waste impacts for a 40/60 recycling/landfill split. A 10/90 split and a 100% recycled hypothetical impact assessment were both calculated, with no significant difference.*

Flow Chart

The below flow chart illustrates the process flow for Tenere activewear garments, from raw ingredients to warehousing. The flow chart is modeled after the Transit Short. However, it should be noted that flow of materials is similar for all other garments.



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Limitations

This LCA calculator includes all known aspects of Tenere's garment manufacturing process, including manufacturing production information, transportation between facilities and delivery to its warehouse in California. However, in some instances, primary data was not obtainable for certain areas of the LCA, either in part due to the fact that Tenere is in the process of launching its company (and therefore does not yet have all primary data generated) or because region-specific data was not available.

GreenStep attempted, where possible, to compare similar criteria across all LCA stages, but acknowledged that in some cases, this was not possible due to the availability of data, mainly due to COVID-19 related constraintsIn these instances, GreenStep was required to seek secondary data outside of the geographical areas in which Tenere operates.

Assumptions

Fabric Formulation

- Tenere uses recycled elastane (Roica™) in its garments. The HIGG MSI does not have impact values for recycled elastane. Roica™ provided Tenere with data to confirm that its process results in a 58% reduction in CO2e impact at the fabric formulation and fabrics stages of the LCA. Therefore, the impacts associated with virgin elastane have been calculated and then reduced by 42%.
- GreenStep made use of the HIGG MSI to model Tenere fabric blends and obtain specific LCA data at the pre-processing stage (i.e. raw material extraction to yarn formation "gate")
- Trims (including zippers) were excluded from this analysis; it was assumed that they would have negligible impact in relation to garment impacts.
- Digital dye process data was not available in the HIGG MSI, but because it is a closed loop process, its water impact at the fabric formulation stage for "woven fabric" was assumed to be zero.

Transportation

- Germany to Taiwan transport during pre-processing phase assumed to travel via Suez Canal

- Transport pre-garment manufacturing stage: CO2e values account for garment wastage + garment weight (vs. just garment weight) - to model bolts of fabric being transported to mill for manufacture
- Road, Ship and Air transportation were standardized to:
    - Road (truck): 1,453.42 km
    - Ocean Freight: 22,420 km
    - International Aircraft: 16,193.56 km

Warehousing / Retail

- Retail phase was not included in this LCA

Use Phase / Consumer Care

- The downstream emission "gate" was identified as Tenere's warehouse in California
- Consumer care was assumed to include cold-water wash and hang dry, with a life span of 50 washes
- GreenStep assumed that during consumer care, one of Tenere's garments would make up 2% of a full load of laundry.
- Consumer care modeled on Transit Short

Waste

- Cut/Sew: 2.5% waste at garment manufacturing stage
    - To minimize waste and increase yield, Tenere worked with their garment manufacturing partners to increase efficiency via digital print and laser cut technologies.
- Packaging (across all garments):
    - 40% recycled
    - 60% landfilled
- Garment end-of-life:
    - Assume five year life-span of garments, followed by:
        - 15% donated/recycled
        - 85% landfilled

LCA Output Tables

The below data include the outputs from Tenere's Life Cycle Impact Analysis. These data identify the impacts from Tenere activewear garments, from raw material production to end-of-life. The impacts are identified as carbon emissions (kg CO2e or carbon dioxide equivalent), water consumption (in litres), and waste disposal/recycling (measured in kilograms or kg).

Impacts were modeled in two ways: the first was based off an initial production run comprising 100% air shipment of garments to warehouse (Indonesia to Los Angeles, California); the second was based off the second (and future) production runs which will comprise 100% ocean freight transport of garments to warehouse.

Initial Production Run - 100% air shipment (garment to warehouse)				
Garment	**Fabric**	**Total CO2e (kg)**	**Total Water (L)**	**Total Waste (kg)**
Transit Short	36GG Knit, Woven Fabric	9.26	232.12	0.28
Transit Liner Short	36GG Knit, Woven Fabric	13.71	241.39	0.45
Eclipse Legging	36GG Knit Fabric	8.33	122.84	0.38
Eclipse Bike Short	36GG Knit Fabric	6.25	118.53	0.30
Astral Legging	28GG Knit Fabric	9.24	124.72	0.42
Astral Bike Short	28GG Knit Fabric	6.93	119.85	0.33

Table 1: Final Outputs from the LCA, for Tenere's initial production run, using 100% air shipment of garments to warehouse *(Water consumption includes an assumed consumer use phase of 50 washes over the life span of one garment)*

Second and Future Runs - 100% ocean freight transport (garment to warehouse)				
Garment	**Fabric**	**Total CO2e (kg)**	**Total Water (L)**	**Total Waste (kg)**
Transit Short	36GG Knit, Woven Fabric	6.23	231.41	0.28
Transit Liner Short	36GG Knit, Woven Fabric	8.07	240.08	0.45
Eclipse Legging	36GG Knit Fabric	3.69	121.76	0.38

Eclipse Bike Short	36GG Knit Fabric	2.82	117.73	0.30
Astral Legging	28GG Knit Fabric	4.06	123.51	0.42
Astral Bike Short	28GG Knit Fabric	3.12	118.97	0.33

Table 2: Final Outputs from the LCA, for Tenere's second and future production runs
(Water consumption includes an assumed consumer use phase of 50 washes over the life span of one garment)

Interpreting Results

Carbon emissions: Carbon impacts are greatest at the fabric formation stage, as well as at the transportation stage, particularly where international air transport is concerned. As Tenere shifts to ocean freight for its garment logistics transport, these values will decrease. The impacts across garment types are similar, but there are obvious differences, for example between the Transit Liner Short and the Transit Short. These differences are likely due to a) the weight of the garment (Transit Liner Shorts are heavier than Transit Shorts) and b) the composition of fabrics these shorts are composed of (a blend of woven and knit fabrics). In the analysis, the method of knitting appeared to generate a lower impact generally than did weaving of the same yarns.

Water consumption: Similarly with carbon emissions, water consumption values follow similar trends in terms of garment weight and composition (i.e., the heavier the garment and more materials use, the higher the water footprint). It should be noted that while the water values may look high, this is typical for garments. The majority of this water footprint occurs at the fabric dyeing and finishing stage, and at the consumer care phase, i.e. washing the garments. For this LCA, GreenStep assumed a consumer use phase of 50 washes over the life span of one garment.

Solid waste: Due to the very minimal amount of packaging used by Tenere to ship its garments, combined with conservative end-of-life scenarios, the results demonstrate that its waste footprint is also minimal, per-garment. As mentioned in the Methodology, a 10% recycle/90% landfill assessment was conducted, as well as a 100% recycle scenario (for packaging materials specifically) and no significant differences were observed in the data. It should be noted that textile waste is generally higher than other consumer-goods products: this waste can occur at the garment manufacturing stage, but primarily occurs at

the end-of-life stage (due to less available streams for recycling and less quantifiable impact data to assess re-use or donation).

Calculations

Below are the calculations conducted per tab, to achieve the "Final Output" tables in the calculator. To note: MSI Scores gleaned from the HIGG MSI are included in the tables (specifically under "Fabric" and "Fabric Formation" tabs as reference only and are not drawn on for any calculations.

Fabric Formulation Tab

This tab of the LCA calculator is used only to draw out specific impacts on a per-fabric basis, to inform the fabrics tab, and ultimately the garment tab where a detailed breakdown of the impacts of each garment is provided. Each fabric was built using the HIGG MSI, to approximate life cycle values at the pre-processing/yarn formation stages of production.

Fabric Tab

The HIGG MSI Score is obtained by summing the individual MSI scores for each of the fabric formulation stages in the HIGG (Global Warming, Eutrophication, Water Scarcity, Resource Depletion, and Chemistry). The Fabric weight (gsm), Bolt Width (inches), and fabric dyeing information were provided by Tenere, and Bolt Width (cm) calculated by GreenStep.

The CO2e and water scarcity values are drawn from the HIGG - using primary LCA data informed by industry partners and other LCA datasets (including GaBi, ecoinvent, and Quantis) - as well as data provided by Tenere, courtesy of Roica, its recycled elastane provider.

Fabric Name	HIGG MSI Score (for reference only)	tenere CO2e (kg CO2e per kg fabric)	Water Scarcity (m3)	Fabric Weight gsm	Bolt Width inches	Bolt Width (cm)	Dyed
36GG Knit Fabric	32.47	8.73	1.99	225	51.5	130.81	Y
28GG Knit Fabric	27.7	8.72	1.98	240	49	124.46	Y

Woven Fabric	70.68	30.92	4.31	160	48	121.92	Y

Table 3: Values listed under the Fabrics Tab *(note: HIGG MSI score is a cumulative sum of all total impacts per fabric as listed in the HIGG, across fabric formulation stage)*

Garment Tab

The Garment tab is the main event of the LCA calculator, and is where all of the carbon, water, and waste impact data are located. The columns in green are what is summed for the "Final Output" tab. The following are the specific calculations:

- *Yield (meters):* data provided by Tenere
- *Length per garment (cm):* Multiply yield by 100 to obtain a value in centimeters
- *Material per garment (m2):* Obtained by multiplying the garment weight (column H) by a "vlookup" call-out to the Fabric Tab (to only pull on data from the "Bolt Width (cm)" column (G) and multiplying this value by 0.001 to scale this value to square meters.
- *Garment wastage + Garment weight (kg):* calculated by GreenStep to approximate the weight of the fabrics before they are formed into garments: these values informed the upstream emissions section of the Transportation tab. Values obtained by dividing the Cut/Sew waste weight per garment by two, and adding this value to the weight of the garment.
- *Fabric CO2e (kg):* Obtained by a similar "vlookup" to the material per garment calculation. This time, calling upon the specific fabric type and CO2e value (in the Fabrics tab, column C), dividing this value by a GreenStep derived kg CO2e-constant of 0.956 (Conversion Tables, F3), and multiplying the result by the garment weight.
- *Cut/Sew CO2e (kg):* calculated in the Cut/Sew Tab
- *Garment Packaging CO2e (kg):* calculated in the Packaging Tab
- *Surface Transport CO2e kg (upstream):* a sum of all garment-specific values in the Transportation Tab.
- *International Air Transport CO2e kg (upstream):* calculated in the Transportation Tab
- *Ground Transport CO2e kg (downstream):* sum of downstream emissions, calculated in the Transportation Tab
- *Ocean Freight Transport CO2e kg (downstream):* calculated in the Transportation Tab
- *International Air Transport CO2e kg (downstream):* calculated in the Transportation tab

- *Warehouse CO2e (kg):* Ship box volume (Conversion Tables B31), garment pack number (in the Garment Tab, column D), a m3m2 conversion factor (Conversion Tables E3), and an average LA warehouse energy coefficient (Conversion Tables D7, obtained from the US Energy Information Administration).
- Consumer Care Wash CO2e (kg): calculated in the Consumer Care Tab
- *Solid Waste CO2e (kg):* sum of values calculated in the Waste Tab
- *Total CO2e (initial shipment by air):* sum of all CO2e columns, omitting ocean freight.
- *Total CO2e (future shipments by ocean freight):* sum of all CO2e columns, omitting international air.
- *Fabric Water (L):* obtained by a similar "vlookup" to the fabric CO2e calculation. Vlookup calls on Fabrics Tab, Column D (Water Scarcity) for the specific fabric type, divided by a m3 conversion factor of 37.849. This value is multiplied by the garment weight and multiplied again by 1000 to obtain Litres of water consumed per garment.
- *Cut/Sew Water (L):* calculated in the Cut/Sew tab (note: Tenere does not use any water at its garment cut/sew phase, so these values were assumed to be zero)
- *Garment Packaging Water (L):* calculated in the Packaging tab
- *Ground Transport Water (L):* garment weight multiplied by the amount of water (in litres) per kilogram of freight (Conversion Tables F65)
- *Ocean Freight Transport Water (L):* garment weight multiplied by the amount of water (in litres) per kilogram of freight (Conversion Tables F66)
- *International Air Transport Water (L):* garment weight multiplied by the amount of water (in litres) per kilogram of freight (Conversion Tables F68)
- *Warehouse Water (L):* calculated using ship box volume, pack number, m3m2 conversion, average warehouse water consumption (litres/m2/day) for Los Angeles, multiplied by 10 to obtain final value in litres
- *Consumer Care Wash Water (L):* calculated in Consumer Care Tab
- *Total Water L (initial shipment by air):* sum of all water columns, omitting ocean freight.
- *Total Water L (future shipments by ocean freight):* sum of all water columns, omitting international air.
- *Total Solid Waste (kg):* calculated in the Waste Tab

Cut/Sew

The Cut/Sew tab calculates CO2e (kg), water consumption (L), and waste (kg) for each of the Tenere garments. Note: because there is no water consumption at this phase of the life cycle, the values in the water column are zero.

- *CO2e (kg):* garment weight multiplied by kg CO2e/kWh for average Asian garment finishing (Conversion Tables G17, *derived from Huang, et al - see References*)
- *Waste (kg):* assumed to be 2.5% of garment weight, calculated by multiplying garment weight by .025

Transportation

The Transportation tab calculates CO2e (kg) for each of the transportation routes along the Tenere supply chain, from raw material recycling and pre-processing, to final transport to warehouse. The emissions have been split between upstream and downstream emissions. Kilometers have been approximated, using Google Maps and Google Earth.

- *CO2e (kg):* kilometer distance multiplied by CO2e/kg/km coefficient for specific transport mechanism (Conversion Tables F58, F59, or F62).

Packaging

The Packaging tab calculates the CO2e, water, and waste for each of Tenere's packaging items: single-ply tissue paper (100% recycled content); mailers (100% recycled paper); poly bag liner (100% recycled content); and a cardboard ship box (100% recycled content). End-of-life was assumed to be 60% of materials landfilled and 40% recycled. (Note: impacts were modeled using a more conservative percentage breakdown (90% landfill, 10% recycling, with no significant difference)

- *CO2e (kg):* weight of packaging per garment multiplied by kg CO2e/kg coefficient for specific packaging type (Conversion Tables D21, D23, D24, D25)
- *Water (L):* weight of packaging per garment multiplied by L water/kg coefficient for specific packaging type (Conversion Tables E21, E23, E24, E25)
- *Waste (kg):* weight of packaging per garment multiplied by the percentage of end-of-life scenario (landfill or recycling: 0.6 or 0.4, respectively)

Consumer Care

The Consumer Care tab calculates CO2 and water impacts for a lifetime of washes, modeled on the Transit Short. Impacts were modeled using the Whirlpool-WFW85HEF and

-WTW8000D washers, and assumed to be air-dried (therefore, no drying impacts were calculated)

- *CO2e (kg):* kWh/load multiplied by number of loads (assumed to be 50 over the garment lifetime); this value multiplied by kg CO2e/kWh coefficient for Western America power grid
- *Water (L):* litres/load multiplied by number of loads

Waste/End-of-Life

The Waste tab calculates CO2e from waste for each of the garments analyzed, along with total solid waste generated. The Cut/Sew Phase has been added to this tab, to account for waste generated at the cut/sew phase. Note: values were calculated for garment waste as well as packaging waste, assuming 85% of garments are landfilled and 15% are recycled; 60% of packaging is landfilled, and 40% is recycled.

- *Cut/Sew CO2e (kg):* cut/sew landfill weight multiplied by kg CO2e/kg coefficient for landfill textiles (Conversion Tables B79)
- *Garment landfill CO2e (kg):* garment weight multiplied by kg CO2e/kg coefficient for landfill textiles (Conversion Tables B79)
- *Garment recycle CO2e (kg):* garment weight multiplied by kg CO2e/kg coefficient for garment recycle
- *Packaging landfill CO2e (kg):* total solid waste landfilled (packaging, Column K) multiplied by kg CO2e/kg for US landfill
- *Packaging recycle CO2e (kg):* total solid waste recycled (packaging, Column L) multiplied by kg CO2e/kg for kg CO2e/kg coefficient for US co-mingled recycling (Conversion Tables B89)
- *Cut/Sew solid waste (kg):* calculated in Cut/Sew tab
- *Garment landfill solid waste:* weight of garment multiplied by 0.85 (percentage assumed to be landfilled)
- *Garment recycle solid waste:* weight of garment multiplied by 0.15 (percentage assumed to be recycled)
- *Packaging landfill solid waste:* calculated in the Packaging tab
- *Packaging recycle solid waste:* calculated in the Packaging tab

Overall Impact

Based on the LCA outputs, it can be demonstrated that the impact of Tenere activewear is similar across all of its garment categories, with the majority of the impact occurring at the fabric formulation stage. Below, the CO2e and water impacts from the fabric stage specifically are summarized across all garments.

Garment	Fabric	Fabric CO2e kg	Fabric Water L
Transit Short	36GG Knit Fabric Woven Fabric	5.0624	18.8453
Transit Liner Short	36GG Knit Fabric Woven Fabric	6.5669	27.5068
Eclipse Legging	36GG Knit Fabric	2.6866	15.4669
Eclipse Bike Short	36GG Knit Fabric	1.9881	11.4455
Astral Legging	28GG Knit Fabric	2.9973	17.2148
Astral Bike Short	28GG Knit Fabric	2.2071	12.6764

Table 4: CO2e and water impacts from the fabric formulation stage of Tenere's LCA

Additionally, a unique finding from this LCA is the impact of knitting versus weaving fabric in preparation for garment manufacturing. Tenere uses a combination of knit and woven materials for its Transit Shorts line, but only knitted fabrics for the Eclipse and Astral shorts and leggings lines. The impact difference is most obvious in the Fabric Formulations tab (data below) and the specific impact appears to occur with respect to weaving of rPET yarn (according to HIGG MSI LCA data). This is presumably due to a few factors, including a) the preparation of yarns for weaving includes a sizing and desizing process to strengthen yarns and prevent breakage during weaving and b) woven material requires more energy to produce, versus the same amount in knitted form due to how yarns are transported in the weaving loom.

Fabric Name	Fabric Composition	Yarn Formation	Total kgCO2e per kg fabric	Total Water Consumption (m3)
Woven Fabric	86% rPET	Woven	27.93	3.12
	14% Recycled Elastane		2.99	1.19

Table 5: Woven Fabric impacts (CO2e and total water consumption)

Recommendations

As the issue of plastics, materials, and textiles recycling continues to be a major topic in the realm of sustainability and consumerism, there is a shift in the consumer marketplace in support of products and practices with a greater focus on sustainability across the entire supply chain.

The following summarize several key recommendations for Tenere, based on the results of this LCA:

- ❏ Continue to minimize, where possible, the use of fossil-fuel based synthetics in the supply chain; offset the use or shedding of plastic that is currently unavoidable (the biggest attribute being microfiber fragmentation and its related impact).
- ❏ Continue to minimize, where possible, the use and wastage of water in the supply chain; offset any current water use and/or water waste.
- ❏ Continue shifting trans-Pacific logistics to ocean-freight to minimize carbon footprint. The impact difference has been modeled in this LCA and GreenStep recommends that Tenere communicate this difference to its customer base as it grows.
- ❏ Work with garment manufacturers and suppliers who make use of renewable energy, to cut down on manufacturing emissions.
- ❏ Continue building partnerships with manufacturers that use digital technologies to reduce environmental impact, just as has been done with the current digital print and laser cut workflows.
- ❏ Maintain and enhance inclusion of recycled content in garments and communicate the positive impact of these decisions to customer base.
- ❏ Consider the differences in impact from knit material vs. woven, and whether or not woven fabric can be replaced with another, similar, textile to achieve the same end-goal.
- ❏ GreenSteep suggests making further use of these LCA data to inform a formal and robust Carbon Neutral certification after Tenere has been established as a business for the required time period.

- ❏ Poll customers as they use Tenere garments on their activewear disposal habits, to build a case for promoting garment reuse or recycling.
- ❏ This LCA assumed 15% of Tenere activewear garments are donated, while 85% are landfilled; in the future, Tenere looks forward to working with enhanced garment and textile recycling schematics that would be able to capture more of its product at end-of-life, and keep these materials out of landfill.

Conclusions

Typically, businesses conduct life cycle assessments after their business has already begun generating revenues and after several production runs, or after so many years of being in business. Tenere is unique in that they are attempting to assess their impact as they launch their business. This LCA provides tangible, baseline evidence for the Tenere customer base that it is trying to do the right thing, by assessing its impact before ramping up production. In this way, Tenere now has the flexibility to pivot and make tweaks to its formulations (if it so chooses) and to communicate these findings to its growing online audience and bring them along for the ride.

There is no such thing as a product with "zero" impact, but certain decisions made along the supply chain can make a drastic difference in the amount of total carbon emitted, water consumed, and waste generated. Additionally, knowing where the greatest impacts along a garment's life cycle occur is crucial to identifying strategies for lowering those impacts.

The results of this LCA demonstrate that while Tenere garments *do* have impact, they have established a baseline from which to improve upon. While this LCA cannot begin to estimate the untold intrinsic, positive impacts its garments will have on its customer base (for example: the positive, mental health impacts that stem from finding joyous movement in garments that feel good), it is obvious that by purchasing Tenere products, customers can feel confident knowing that the team behind Tenere is making every effort to do the right thing, for people and planet.

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Appendices

The following tables are the result of LCA calculations across all life cycle stages and are separated out into CO2e, water, and waste.

Garment	Fabric	Fabric CO2e kg	Cut/Sew CO2e kg	Garment Packaging CO2e kg
Transit Short	36GG Fabric Woven Fabric	5.0624	0.0125	0.2766
Transit Liner Short	36GG Fabric Woven Fabric	6.5669	0.0233	0.2766
Eclipse Legging	36GG Knit Fabric	2.6866	0.0192	0.1383
Eclipse Bike Short	36GG Knit Fabric	1.9881	0.0142	0.1383
Astral Legging	28GG Knit Fabric	2.9973	0.0214	0.1383
Astral Bike Short	28GG Knit Fabric	2.2071	0.0158	0.1383

CO2e (kg) on a per-garment basis for fabric production, cut/sew stage, and garment packaging

Garment	Fabric	Surface Transport CO2e kg	International Air Transport CO2e kg	Ground Transport CO2e kg	Ocean Freight Transport CO2e kg	International Air Transport CO2e kg

		(Upstream)	(Upstream)	(Downstream)	(Downstream)	(Downstream)
Transit Short	36GG Knit Fabric Woven Fabric	0.1581	0.3465	0.0026	0.0935	2.7782
Transit Liner Short	36GG Knit Fabric Woven Fabric	0.3367	0.6511	0.0048	0.1736	5.1577
Eclipse Legging	36GG Knit Fabric	0.2419	0.5299	0.004	0.143	4.2491
Eclipse Bike Short	36GG Knit Fabric	0.1394	0.3921	0.003	0.1058	3.1444
Astral Legging	28GG Knit Fabric	0.27	0.5916	0.0045	0.1596	4.7436
Astral Bike Short	28GG Knit Fabric	0.1988	0.4356	0.0033	0.1175	3.493

CO2e (kg) on a per-garment basis, for transportation across the supply chain. *(Note that transportation emissions have been split out between upstream and downstream; and between surface transport (i.e., road), international air, and ocean freight)*

Garment	Fabric	Warehouse CO2e kg	Consumer Care Wash CO2e kg	Solid Waste CO2e kg
Transit Short	36GG Knit Fabric Woven Fabric	0.4144	0.1159	0.0938
Transit Liner Short	36GG Knit Fabric Woven Fabric	0.4144	0.1159	0.1585
Eclipse Legging	36GG Knit Fabric	0.2072	0.1159	0.1338
Eclipse Bike Short	36GG Knit Fabric	0.2072	0.1159	0.1038
Astral Legging	28GG Knit Fabric	0.2072	0.1159	0.1473
Astral Bike Short	28GG Knit Fabric	0.2072	0.1159	0.1133

CO2e (kg) on a per-garment basis for warehousing, consumer care, solid waste disposal

Garment	Fabric	Total CO2e (initial shipment by air)	Total CO2e (future shipments by ocean freight)
Transit Short	36GG Knit Fabric Woven Fabric	9.2611	6.2299
Transit Liner Short	36GG Knit Fabric Woven Fabric	13.7059	8.0707
Eclipse Legging	36GG Knit Fabric	8.3259	3.6898
Eclipse Bike Short	36GG Knit Fabric	6.2462	2.8155
Astral Legging	28GG Knit Fabric	9.237	4.0614
Astral Bike Short	28GG Knit Fabric	6.9282	3.1171

Total CO2e across all life cycle stages on a per-garment basis (via alternate shipping mechanisms)

Garment	Fabric	Fabric Water L	Cut/Sew Water L	Garment Packaging Water L
Transit Short	36GG Knit Fabric Woven Fabric	18.8453	0.00	7.1752
Transit Liner Short	36GG Knit Fabric Woven Fabric	27.5068	0.00	7.1752
Eclipse Legging	36GG Knit Fabric	15.4669	0.00	3.5876

Eclipse Bike Short	36GG Knit Fabric	11.4455	0.00	3.5876
Astral Legging	28GG Knit Fabric	17.2148	0.00	3.5876
Astral Bike Short	28GG Knit Fabric	12.6764	0.00	3.5876

Water consumption (L) on a per-garment basis for fabric production, cut/sew stage, and garment packaging

Garment	Fabric	Ground Transport Water L	Ocean Freight Transport Water L	International Air Transport Water L
Transit Short	36GG Knit Fabric Woven Fabric	0.0093	0.0001	0.7078
Transit Liner Short	36GG Knit Fabric Woven Fabric	0.0174	0.0002	1.314
Eclipse Legging	36GG Knit Fabric	0.0143	0.0002	1.0825
Eclipse Bike Short	36GG Knit Fabric	0.0106	0.0001	0.8011
Astral Legging	28GG Knit Fabric	0.016	0.0002	1.2085
Astral Bike Short	28GG Knit Fabric	0.0118	0.0001	0.8899

Water consumption (L) on a per-garment basis for transportation across the supply chain

Garment	Fabric	Warehouse Water L	Consumer Care Wash Water L
Transit Short	36GG Knit Fabric Woven Fabric	0.914	204.4648

Transit Liner Short	36GG Knit Fabric Woven Fabric	0.914	204.4648
Eclipse Legging	36GG Knit Fabric	0.457	102.2324
Eclipse Bike Short	36GG Knit Fabric	0.457	102.2324
Astral Legging	28GG Knit Fabric	0.457	102.2324
Astral Bike Short	28GG Knit Fabric	0.457	102.2324

Water consumption (L) on a per-garment basis for warehousing and consumer care *(Consumer care wash includes an assumed 50 washes over the life span of one garment)*

Garment	Fabric	Total Water L (initial shipment by air)	Total Water L (future shipments by ocean freight)
Transit Short	36GG Knit Fabric Woven Fabric	232.1163	231.4087
Transit Liner Short	36GG Knit Fabric Woven Fabric	241.392	240.0783
Eclipse Legging	36GG Knit Fabric	122.8407	121.7584
Eclipse Bike Short	36GG Knit Fabric	118.5341	117.7332
Astral Legging	28GG Knit Fabric	124.7163	123.5079
Astral Bike Short	28GG Knit Fabric	119.855	118.9652

Total water consumption across all life cycle stages on a per-garment basis (via alternate shipping mechanisms)

Garment	Fabric	Total Solid Waste kg
Transit Short	36GG Knit Fabric Woven Fabric	0.2769
Transit Liner Short	36GG Knit Fabric Woven Fabric	0.4458
Eclipse Legging	36GG Knit Fabric	0.3813
Eclipse Bike Short	36GG Knit Fabric	0.3029
Astral Legging	28GG Knit Fabric	0.4164
Astral Bike Short	28GG Knit Fabric	0.3276

Total solid waste generated (kg) across all life cycle stages on a per-garment basis, per garment