



# Measuring Sustainability: Environmental Impacts

The standardized list of impact category indicators is addressed under the LEO-SCS-002 LCA standard (currently undergoing public review under the ANSI process). Additional site-specific indicators may be identified in a given LCA study.

## RESOURCE DEPLETION

### Energy Resource Depletion

- Refers to: Depletion of non-renewable energy resource reserve bases.
- Significance: Depletion of these resources will present profound challenges to world energy production.
- Calculation: Consumption weighted by timeframe of depletion of reserve base (by resource) compared to oil.

### Water Resource Depletion

- Refers to: Drawdown or contamination of regional water supplies, above and below ground.
- Significance: Leads to less potable water, less water for irrigation and other uses.
- Calculation: Consumption weighted by rate of depletion in excess of recharge rates for regional sources. Emphasis on drought areas.

### Minerals and Metals Resource Depletion

- Refers to: Depletion of specific mineral and metal reserve bases.
- Significance: Depletion of strategic and rare minerals and metals affects product manufacturing capabilities.
- Calculation: Consumption, considering timeframe of depletion of reserve base (by resource).

### Biotic Resource Depletion

- Refers to: Depletion of natural resources for human uses (e.g., wood, fish).
- Significance: Overfishing and deforestation are two examples of excessive depletion.
- Calculation: Incorporates size of reserves, rate of depletion, and rate of regrowth (or restocking).

## LAND USE ECOLOGICAL IMPACTS

### Terrestrial Biome Disturbance

- Refers to: Degree to which human activities impacting forests, grasslands, and other land biomes affect flora and fauna.
- Significance: Disruption of ecosystems and biomes that have evolved over millennia.
- Calculation: Spatial extent, duration, and severity of disturbance to unique biomes measured site-specifically.

### Freshwater Biome Disturbance

- Refers to: Degree to which human activities impacting rivers, streams and creeks affect flora and fauna.
- Significance: Disruption of sensitive riverine ecosystems and biomes that have evolved over millennia.
- Calculation: Spatial extent, duration, and severity of disturbance measured on a watershed basis.

### Riparian and Wetland Biome Disturbance

- Refers to: Degree to which human activities impacting riparian areas and wetlands affect flora and fauna.
- Significance: Disruption of sensitive riparian ecosystems and biomes that have evolved over millennia.
- Calculation: Spatial extent, duration, and severity of disturbance measured on a site-specific basis.

### Loss of Key Species

- Refers to: Human activities affecting populations of threatened, endangered, or other species of concern.
- Significance: Endangerment or extermination of individual species, leading to disruption of ecosystems.
- Calculation: Percent change in population, or disturbance to suitable habitat, for each affected species.

## IMPACTS FROM GREENHOUSE GAS AND BLACK CARBON EMISSIONS

### Global Climate Change

- Refers to: Effects of GHGs and aerosols on global temperatures and climate.
- Significance: Predicted to cause irreversible changes to climate and global ecosystems by 2050.
- Calculation: Uses global warming potentials for GHGs and BC emissions based on 2050 time horizon.

### Arctic Climate Change

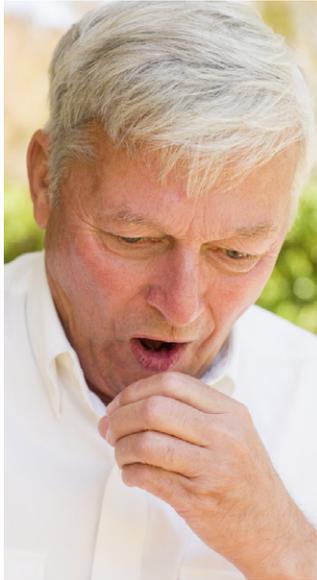
- Refers to: Effects of GHGs and aerosols on Arctic temperatures and climate.
- Significance: Severe habitat disruption and melting of perennial sea ice already underway, potentially leading to catastrophic release of methane hydrates.
- Calculation: Arctic regional warming potential of GHGs and BC emissions using an annual time horizon.

### Ocean Acidification

- Refers to: Increased acidity and altered chemistry of oceans caused by carbon dioxide emissions.
- Significance: Severe ocean ecosystem disturbance.
- Calculation: Measures the 30% of all atmospheric carbon dioxide emissions that dissolve in the oceans.

### Ocean Warming

- Refers to: Increased ocean temperatures caused by GHG and BC emissions.
- Significance: Severe ocean ecosystem disturbance.
- Calculation: Uses global warming potentials for GHGs and BC, accounting for 80% of trapped heat in oceans.



## REGIONAL ENVIRONMENTAL IMPACTS FROM EMISSIONS

### Regional Acidification

- Refers to: Change in pH balance of soil and water caused by acid rain from air pollutants.
- Significance: Disturbance of ecosystems, such as “dead lakes” that cannot support fish life.
- Calculation: Modeling plumes of acidifying emissions and wet deposition on sensitive soils and water bodies.

### Stratospheric Ozone Depletion

- Refers to: Destruction of protective ozone layer in the upper atmosphere caused by air pollutants.
- Significance: Increased ultraviolet radiation hits the earth, harming humans and disrupting ecosystems.
- Calculation: Ozone depletion potentials using parameters established under 1987 Montreal Protocol.

### Ecotoxicity

- Refers to: Toxic chemicals emitted to soils and water.
- Significance: Disturbance of ecosystems and die-offs of species.
- Calculation: Relative ecotoxicity using method from National Oceanic and Atmospheric Administration. [1]

### Eutrophication

- Refers to: Addition of excess nutrients to aquatic environments.
- Significance: Blooms of harmful algae deplete oxygen, disturb ecosystems, and create marine “Dead Zones.”
- Calculation: Dispersion of excess nutrients into water bodies experiencing primary eutrophication.

## HUMAN HEALTH IMPACTS FROM EMISSIONS

### Ground Level Ozone Exposures

- Refers to: Human exposure to ground level ozone (GLO) at levels above human health thresholds.
- Significance: Causes increased rates of asthma in children and respiratory ailments in larger populations.
- Calculation: Air modeling of GLO plumes, exposing populations at levels above health thresholds.

### PM 2.5 Exposures

- Refers to: Human exposure to particulates smaller than 2.5 microns at levels above human health thresholds.
- Significance: Causes severe respiratory and cardiovascular ailments in exposed populations.
- Calculation: Air modeling of particulate emissions plumes exposing human populations.

### Toxic Emissions – Effects from Inhalation (Chronic, Non-Carcinogenic)

- Refers to: Toxic chemical emissions linked to chronic health effects through inhalation.
- Significance: Causes developmental problems in children and other ailments in exposed populations.
- Calculation: Air modeling of emission plumes exposing populations at levels above human health thresholds, considering toxicity of each chemical. [2]

### Toxic Emissions – Effects from Inhalation (Carcinogenic)

- Refers to: Toxic chemical emissions linked to cancer through inhalation.
- Significance: Causes cancer and non-malignant tumors in exposed populations.
- Calculation: Air modeling of emission plumes exposing populations, considering carcinogenicity of each chemical. [3]

### Indoor Air Toxic Emissions – Effects from Inhalation

- Refers to: Adverse health effects to humans through inhalation of toxic chemicals in the indoor environment.
- Significance: Variety of human health ailments in exposed populations, depending on chemicals.
- Calculation: Modeled emission levels over risk threshold (CREL [4]), incorporating relative chemical toxicity.

### Toxic Emissions – Effects from Ingestion (Chronic, Non-Carcinogenic)

- Refers to: Toxic chemical emissions linked to chronic health effects through ingestion.
- Significance: Causes developmental problems in children and other ailments in exposed populations.
- Calculation: Emissions of persistent or bioaccumulative toxic chemicals, incorporating relative toxicity.

### Toxic Emissions – Effects from Ingestion (Carcinogenic)

- Refers to: Toxic chemical emissions linked to cancer through ingestion.
- Significance: Causes cancer and non-malignant tumors in exposed populations.
- Calculation: Emissions of persistent or bioaccumulative toxic chemicals incorporating relative carcinogenicity.

## RISKS FROM UNTREATED HAZARDOUS AND RADIOACTIVE WASTES

### Risks from Radioactive Wastes

- Refers to: Risks presented by breach of containment of nuclear wastes.
- Significance: Potential radioactive contamination, affecting human health and ecosystems.
- Calculation: Amount of radiation from WIR [5], high- and low-level nuclear wastes produced.

### Risks from Hazardous Wastes

- Refers to: Risks presented by breach of containment of other hazardous wastes (by type of waste).
- Significance: Toxicity, flammability, and/or acute and chronic impacts on humans and the environment.
- Calculation: Amount of hazardous wastes generated.