The University of Zambia
School of Engineering
Dept. of Civil & Environmental Engineering

CEE 4412: Environmental Engineering

JMT

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Course contents

The following are the course contents

- Introduction (What is environmental Engineering? Scope, The Environmental Engineer, Environment and Public health)
- Water Quality (Significance of parameters, Examination and characterisation)
- Water Supply (Water demand; sources, Distribution systems, water treatment-unit operations; Rural and peri-urban water supply systems)
- Wastewater (Quantification, types, characteristics, Off-site sanitation systems: collection and conveyance, treatment,
- Onsite Sanitation systems. Faecal Sludge Management – Introductory aspects
- Solid waste (Characteristics; modes of collection, design of collection facilities, location of dumping sites, disposal methods)

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The Environment?

- To understand the scope of our course, there is need to first understand what Environment is. Environment is defined as the physical (abiotic) and biotic habitat that surrounds us; that we can see, hear, smell, touch and taste including ourselves

Environmental Engineering – Historical Developments

- Environmental Engineering as a subset of the Civil Engineering profession has its roots in the beginning of civilisation
- Civilisation lead to industrialization which resulted in people congregating in organised communities
- Communities survival depended on nature for continued supply of water/sanitation facilities
- As communities grew, the need for proper management of resources became an issue
- Pollution increased (Water supply, sanitation became a challenge
- Some military engineers switched to address Pollution problems related to the civil population and these became known as the CIVIL Engineers

Environmental Engineering – What is it?

- **To appreaciate EE, we first define Pollution:** An undesirable change in the physical, chemical, or biological characteristics of the air, water or land that can harmfully affect the health, survival, or activities of humans or other organisms

- The engineering and science we apply to abate or mitigate pollution = Environmental Engineering

Environmental Engineering – What is it?

EE= measures we put in at this point so that we have sustainable development. SD=development that meets the needs of the present without compromising the ability of future generations to meet their own needs

Scope Environmental Engineering

- Extremely Broad
  - Environmental impact assessment and mitigation
  - Radiation protection
  - Public health issues including which is the gist of our course and involves:
    - Water supply and treatment
    - Wastewater conveyance and treatment
    - Faecal Sludge Management
    - Air quality management
    - Solid waste management (ETC)

Tasks of an Environmental Engineer

- Environmental engineers develop solutions to environmental problems using the principles of science. Tasks include:
  - Preserving the present condition of the environment;
  - Protecting the environment from further degradation; and
  - Remediating/Enhancing the environment.
- By so doing, protecting people and the environment from adverse impacts related to environmental pollution.

Environment and Public Health – Environmental Health Engineering (PHE)

- What is Environmental Health Engineering or Public Health Engineering?
  - Component of Environmental Engineering (subset) that deals with aspects of human health as it relates to environmental conditions
  - EHE/PHE can therefore be defined as the application of engineering principles to the control, modification or adaptation of the physical, chemical and biological factors of the environment in the interest of man's health and social well-being. Fortunately, as we put in these measures, mostly, we also address impacts on the environment in general fot the benefit of other species
  - Aims at abating or minimising Environmental Pollution wrt to human health.

Types of Pollution significant to EHE/PHE

Diseases of Public Health Significance and their Causes

- Public Health: The health of a community/population

- Diseases of Public Health significance are communicable diseases

- Communicable diseases are *"diseases which can be transmitted from one person to another or from an animal"*

(Not chronic or genetic diseases)

Environmental Classification of Communicable Diseases

PHE seeks to contain diseases by taking measures on the environment in which they thrive. As such, from the perspective of EHE or PHE, diseases are categorized as:

- Water-related diseases
- Excreta-related diseases
- Refuse-related diseases
- Housing-related diseases; and
- Air-borne diseases.

Note that we place emphasis on the environment that promotes proliferation of the disease (i.e. air, water etc)

Water- Related Diseases

This Group Comprises:

- Water-borne (Faecal-oral)
- Water-based (Water-contact)
- Water-related Insect Vector (Water-vector Habitat) Diseases
- Water-washed (Water-hygiene)

Water borne (Faecal-Oral)

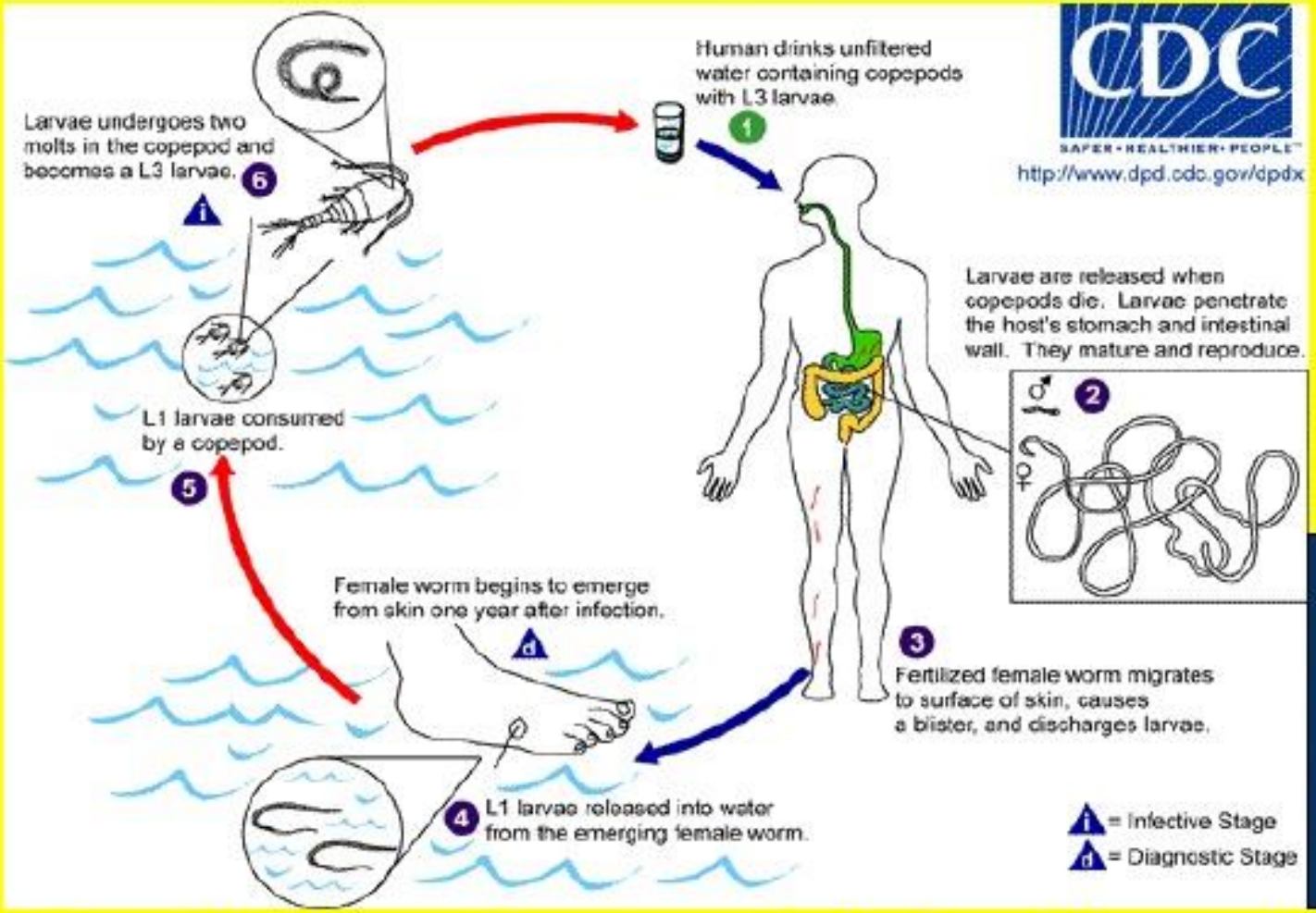
- Examples are enteric diseases-a disease of the intestines caused by any infection (Cholera, diarrhea, dysentery etc)

- Mostly caused by ingestion of contaminated water or food

- EHE address this category of diseases through
  - microbiological water treatment
  - Prevention of contamination of water sources and water in distribution and storage facilities.
  - increasing public hygiene health campaigns.

Water-based (water-contact)

- Schistosomiasis
- Dracunculiasis (Guinea worm disease)



Schistosomiasis affects over 200 million people worldwide, of whom 88 million are under 15 years of age

Life cycle of the guinea worm infection (dracunculiasis)

Water-based (water-contact)

Here there is an intermediate host called a vector necessary to complete the cycle of the pathogen.

Excreta → water → snail → water → skin

Measures

- Decreasing the need for contact with infected water (e.g. provision of boreholes for rural communities)
- Reducing contamination of surface water by excreta; and
- Applying measures of vector control (i.e. for schistomiasis, kill snails)
- increasing public hygiene health campaigns.

Water-related insect vector (water-vector habitat) diseases

- Diseases that are spread by biting insects which either breed in water or bite near water. Measures include:
- Improving surface water management;
- Improving solid waste management;
- Destroying breeding sites of insects;
- Control the number of adult insects; and
- Keep the population away from breeding sites.
- increasing public hygiene health campaigns.

Water-washed (water-hygiene)

- Hygiene type of diseases. Caused as a result of water shortages … and lack of hygiene

- Measures
  - increasing water quantities;
  - improving water accessibility and reliability; and
  - increasing public hygiene health campaigns.

Trachoma Stages

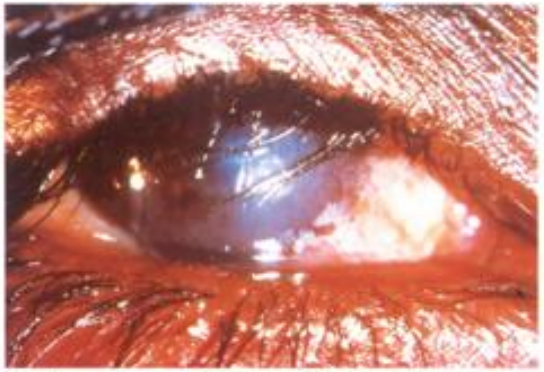
***TRACHOMATOUS SCARRING (TS)**: the presence of scarring in the tarsal conjunctiva.*

Scars are easily visible as white lines, bands, or sheets in the tarsal conjunctiva. They are glistening and fibrous in appearance. Scarring, especially diffuse fibrosis, may obscure the tarsal blood vessels.

Trachomatous scarring (TS)

***TRACHOMATOUS TRICHIASIS (TT)**: at least one eyelash rubs on the eyeball.*

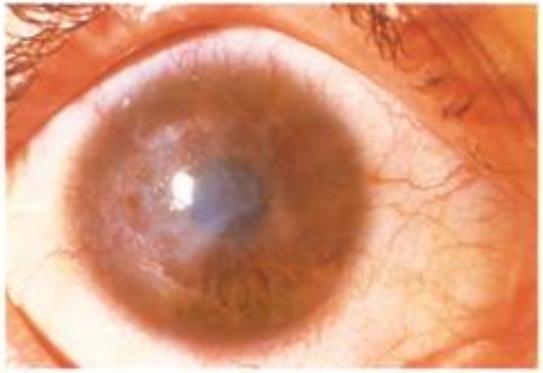
Evidence of recent removal of inturned eyelashes should also be graded as trichiasis.



Trachomatous trichiasis (TT)

***CORNEAL OPACITY (CO)**: easily visible corneal opacity over the pupil.*

The pupil margin is blurred viewed through the opacity. Such corneal opacities cause significant visual impairment (less than 6/18 or 0.3 vision), and therefore visual acuity should be measured if possible.



Corneal opacity (CO)

TF:– give topical treatment (e.g. tetracycline 1%).
TI:– give topical and consider systemic treatment.
TT:– refer for eyelid surgery.

WORLD HEALTH ORGANIZATION
PREVENTION OF BLINDNESS AND DEAFNESS

Support from the partners of the WHO Alliance for the Global Elimination of Trachoma is acknowledged.

Excreta-related Diseases

- Most diseases are caused by pathogens normally found in excreta and so most of them are excreta related. Categorization of excreta related diseases is as follows:
  - Faecal-oral diseases;
  - Soil-transmitted helminth diseases
  - Beef and pork tapeworm diseases
  - Water-based helminth diseases
  - Excreta-related insect vector diseases

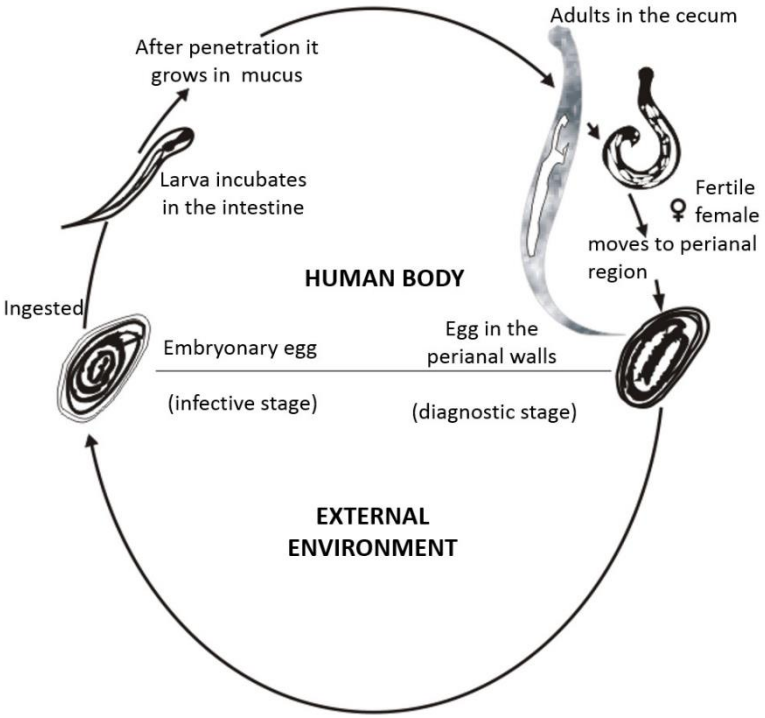
Faecal oral diseases

- This is a direct route.
- May first get to water or food

- Prevention would be by improving the sanitary conditions of the environment including:
  - excreta containment;
  - excreta collection conveyance and treatment;
  - provision of adequate good quality water; and
  - improving personal hygiene which can be done with the help of health hygiene awareness campaigns.

Soil-transmitted helminth diseases

- These are parasitic worms whose eggs are passed in excreta.
- The eggs last for a long time in soil before they mature.
- They can then get to the new host through ingestion.



Enterobius vermicularis **Life Cycle**, Nematode (Pinworm)

- Prevention would be through excreta containment; and
- Avoiding vegetables fertilised with untreated excreta.

Informal use of wastewater in crop production

Vegetables grown using raw wastewater

This piece of intestine, blocked by worms, was surgically removed from a 3-year-old boy at Red Cross Children's Hospital. The child survived, but no child should be subjected to such an easily preventable condition. Photo: Allen Jefthas
Source: MRC POLICY BRIEF – No. 2, APRIL 2006: Worms in SA's children (Medical Research Council, South Africa) – also on I-LE (Extra reading)

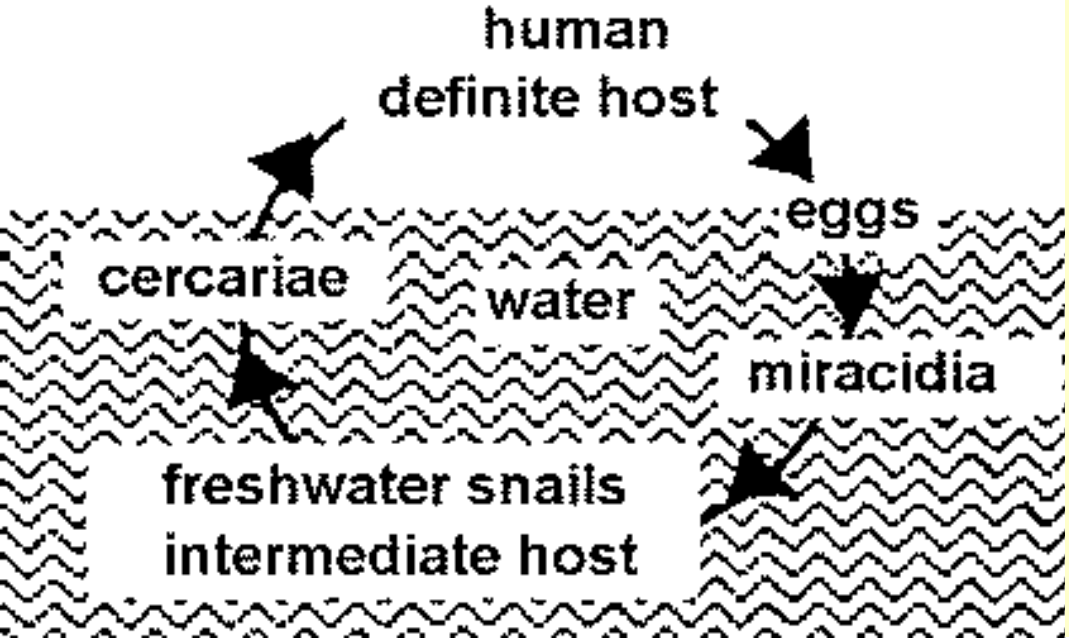
Beef and pork tapeworm diseases

- These are a type of helminth diseases which need an animal host to mature before they can re-infect a human being.
  - This is usually through eating raw meat.
  - The animals get infected from pasture that has been exposed to faecal matter.

  - Prevention is to avoid excreta related contamination of pasture
  - Ensuring adequate cocking of meat before consuption

Water-based helminth diseases

- Not different from the water based diseases discussed under water related.
- The excreta-related helminthes, which are water based, undergo development in an aquatic host (e.g. snail or raw fish or aquatic plants



- Prevention would therefore be by not discharging untreated wastewater or excreta into water bodies.
- Avoiding contact

Excreta-related insect vector diseases

- Examples are malaria by mosquitoes breeding in pit latrines and wastewater facilities.
- Diarrhea and Trachoma (flies and roaches)

- Prevention would be by eradicating the vector
- Hazard containment
- Provision of adequate potable water
- Provision of health and hygiene awareness

REFUSE-RELATED DISEASES

- Solid waste if not properly managed can become a health hazard.
- It would promote breeding of vectors (rats, houseflies, mosquitoes)

- EHE interventions would be through a sound solid waste management system.
- This would entail frequent collection and safe disposal of the solid waste.

Housing-Related Diseases

- Housing has a lot of impacts on human health. The major factors to consider include:
  - Location of house and location of faucets in the house (e.g. on the banks of stablisation ponds or dump sites and no taps in toilets)
  - The design (How is water provided and means of wastewater collection).
  - Ventilation would be another important aspect to consider.
  - Design can also affect population of vectors (e.g. earth floors promote proliferation of maggots or sand-fleas

Aim of Environmental Health Engineering

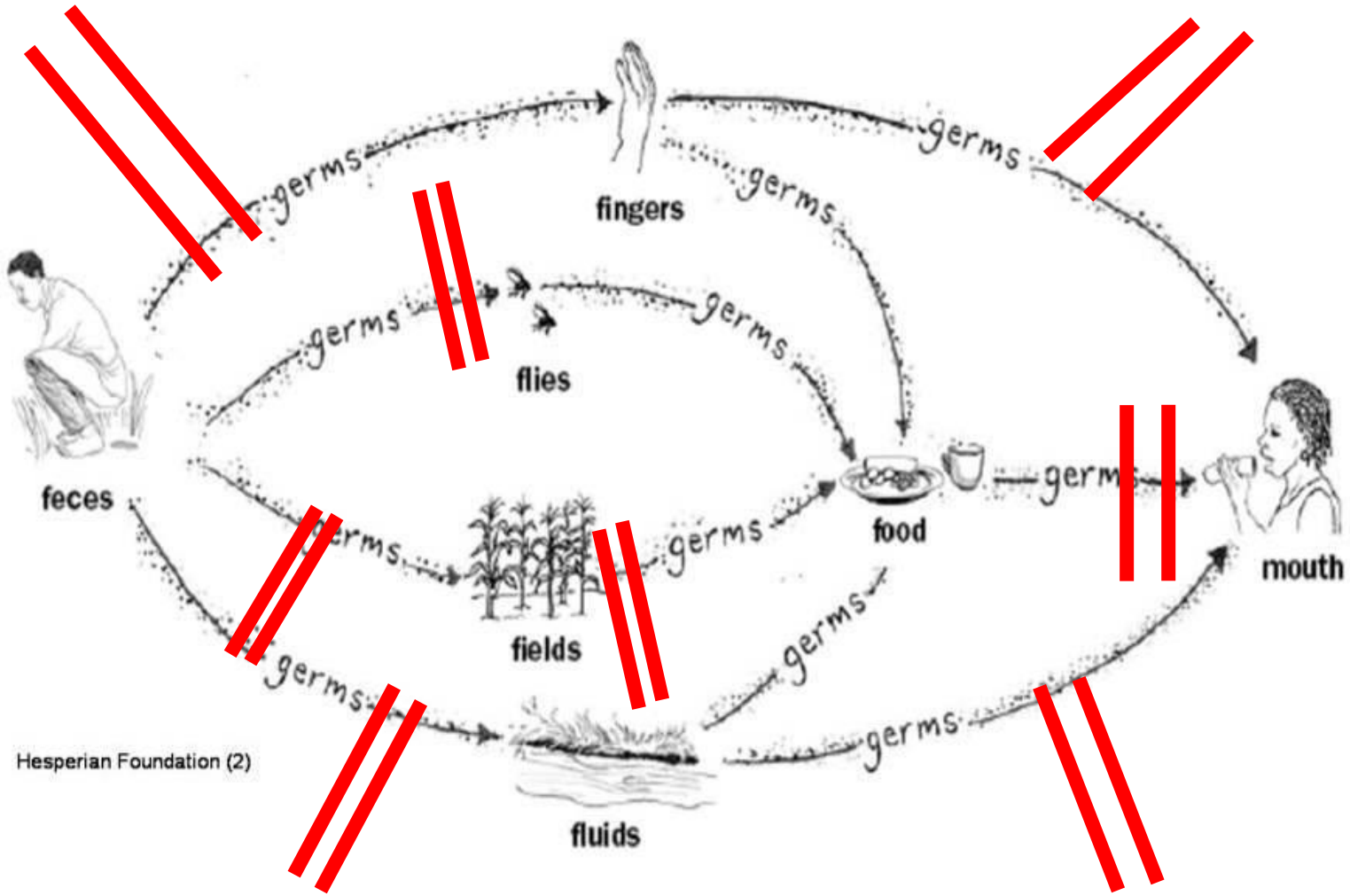
- to break the transmission route of the diseases or breaking the chain by acting on the environment.

- Therefore aims at designing preventive measures (Avoiding curative measures)

Breaking the Chain

BREAKING CHAIN THROUGH FSM

Disease Transmission Routes



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THANK YOU