Background:

The Holderness coastline of Yorkshire is one of Europe's fastest eroding coastlines with an average annual rate of erosion of approximately one to two metres per year. In places today's coastline is now up to four kilometres inland from where it was in Roman times.

Causes

- The coastal bedrock is an unconsolidated weak glacial boulder clays (tills) easily weathered and eroded.
- Beaches are narrow, providing little protection for the cliffs.
- The prevailing north easterly waves attack the coast.
- Large waves undermine the cliffs through abrasion, hydraulic action, freeze thaw weathering and solution etc.
- Longshore drift carries eroded material southwards.

Effects

Primary effects	Secondary effects
• Land slips / slides / slumps • Mud flows • Rock fall and cliff collapse • Erosion of coastline	• Loss of housing (social impact) • Loss of farms, caravan parks and other businesses (economic impact) • Loss of habitat (environmental impact) • Loss of communications

Responses

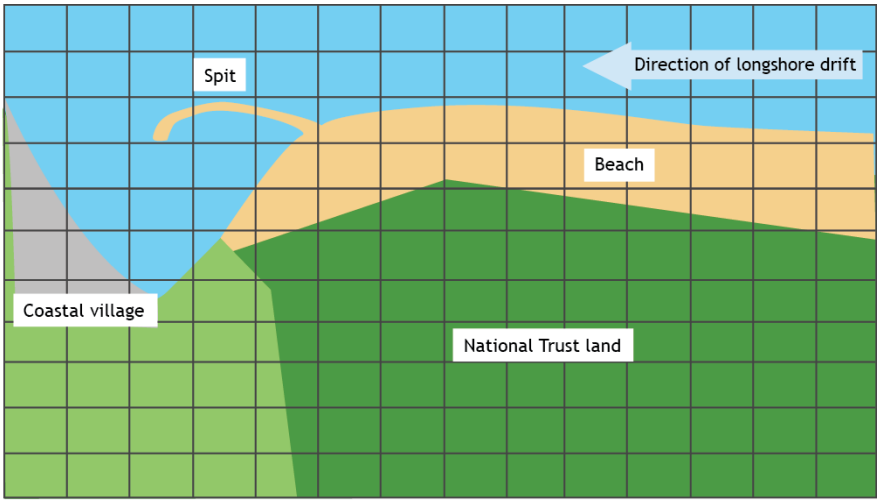
N.B. There are different responses at different locations dependent on advantages, disadvantages and costs. Some responses will involve hard rather than soft engineering.

Short term responses	Long term responses
• Council purchase of cliff top land • Demolition of cliff top properties • Lack of insurance for buildings	• Integrated coastal zone management • Coastal defences, e.g. groynes, seawalls, riprap/rock armour, revetments and gabions etc. • Migration • Hold the line / retreat the line (do nothing)

Decision:

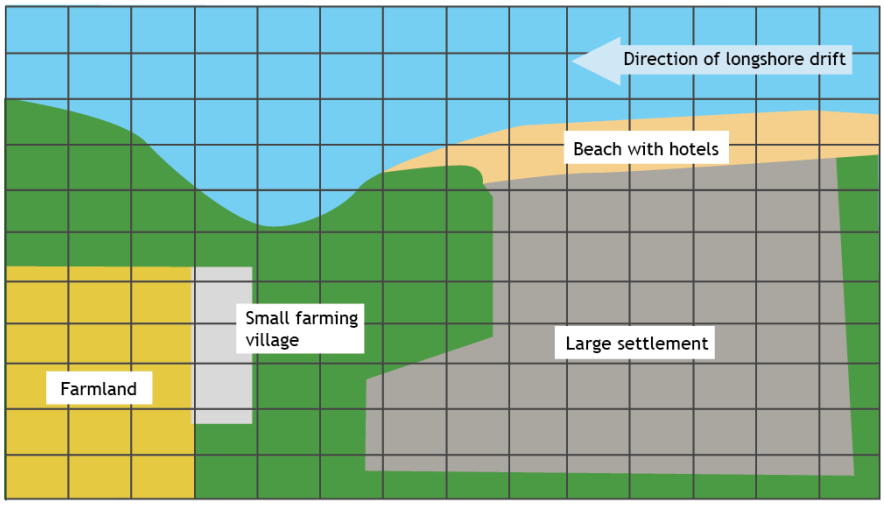
You must choose which area of coastline should be protected from figure 1, figure 2 or figure 3. The Plan is to protect the stretch of coastline with a mixture of hard and soft engineering strategies. Justify your chosen area of coastline to protect and suggest suitable hard and soft engineering methods to manage the rate of coastal erosion.

Figure 1:



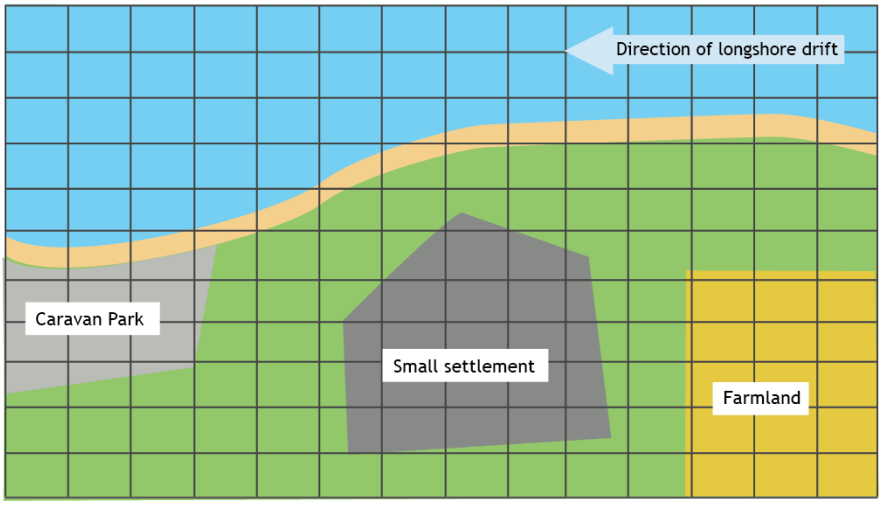
An area of coastline rapidly eroding. The coastal village contains 150 homes and small businesses.

Figure 2:



A section of coastline that is at risk of coastal erosion including a large settlement with over 500 homes.

Figure 3:



An area of coastline rapidly eroding. The small settlement has 250 homes, and the caravan park is the village's main source of income from tourists.

Hard and soft engineering options:

Sea walls

- Sea walls are normally concrete structures erected on the edge of the coastline to create a barrier between the destructive waves which erode the land behind the wall.
- A sea wall protects the base of cliffs and land against the processes of erosion.
- To be affective sea walls are required to cover a significant length of the coastline, and therefore are incredibly expensive to build.
- Curved sea walls are designed to reflect the energy of destructive waves back out to sea.
- Concrete sea walls are strong but not indestructible and over time will erode due to the force of the water. This requires significant maintenance which is also expensive.

Groynes

- Groynes are wooden barriers built at right angles going out to sea. These are seen by many to be an unattractive addition to the coastline.
- They are designed to prevent the movement of sediment along the beach by longshore drift.
- Groynes trap material between them, allowing the build-up of the beach.
- Groynes can be costly to build and maintain.
- Beaches are a natural defence against erosion and an attraction for tourists, which can pay for the maintenance of the groynes.

Rock armour

- Rock armour is primarily using large boulders piled up on the beach to dissipate the energy of the waves to protect the beach.
- Rock armour is generally more natural looking than groynes and a sea wall, and looks less artificial on a beach.
- The placement of the boulders allows the build-up of the beach, but these boulders can also be transported along the beach if there are large destructive waves.
- These structures can be expensive to obtain and transport to the coastline.

Beach nourishment

- This replaces beach or cliff material that has been removed by erosion or longshore drift.
- The main advantage is that beaches are a natural defence against erosion and coastal flooding. Beaches also attract tourists.
- It is a relatively inexpensive option but requires constant maintenance to replace the beach material as it is washed away.

Managed retreat

- Areas of the coast are allowed to erode and flood naturally. Usually this will be areas considered to be of low value, e.g. places not being used for housing or farmland.
- The advantages are that it encourages the development of beaches (a natural defence) and relatively cost is low.
- Managed retreat is a cheap option, but people will need to be compensated for loss of buildings and farmland.