ice
Institution of Civil Engineers

Membership

Rapid Response Engineering Challenge

One Day Challenge, Scotland V1

Overview

The Rapid Response Engineering Challenge (RREC) is an interdisciplinary project based on the engineering response to a natural disaster and is aimed at S1 or S2 pupils (though it can be adapted for other age groups). The Challenge highlights the role of civil engineers, demonstrating the relevance to the world of work, as well as realizing all the positive aspects of a wholly collaborative, and active, interdisciplinary learning experience.

The RREC develops a range of skills for life, work and learning including teamwork and communication and links directly into the development of responsible citizens. Through taking part in the challenge, learners gain an understanding of what life is like in less economically developed countries and grasp the difficulties in providing basic necessities in the event of natural disasters.

Format

The project is comprised of three elements:-

- Launch presentation
- Classroom based activities
- Practical activities (some of which are recommended for outdoors)
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Launch presentation

The RREC is launched at an assembly event where a volunteer civil engineer comes to speak to the pupils about civil engineering and how it affects our lives. The pupils are asked to consider how the fundamentals they take for granted such as shelter, safe drinking water, transportation and communication are put in place in a modern society and then challenged to think how fragile society becomes when one or all of these are not in place.

This presentation is “interrupted” by news of a hurricane. A briefing about the impact the disaster has had on the local community is given and the pupils are told they will then be trained as disaster response engineers to go and help.

Please note that there are two modern language options regarding the launch presentation. The scenario can be located in either a French (Haiti) or Spanish (Honduras) speaking country depending on the preference of the school. Please let the engineer who will be presenting the launch event know in advance which scenario you would like.

Classroom based tasks

The classroom teaching phase of the RREC is intended to last approximately one hour though it is adaptable in terms of length and content. It is recommended that the pupils cover the shelter, water supply & transportation tasks to give a basic level of knowledge before the practical activities. This is intended as a group activity with pupils working in groups of six. They can split the task among three pairs or work collectively on all three aspects. Pages 4 to 9 are intended to be printed out and given to the pupils.

Practical activities

The project culminates with the practical activities. There are a number of available activities that can be used – shelter building, water filtration, water transportation, etc. but again these are not prescriptive and schools are encouraged to develop their own.

Classroom Task 1 – Logistics: Water & Sanitation

You and your group are **WATER and SANITATION ENGINEERS** and have volunteered to go to the disaster area. You are to be responsible for planning a water and sanitation system at the temporary camp for the homeless people of the town.

You have just 30 minutes to make your plans!

1. Name five things you use water for at home.

2. Estimate how many litres of water you use on an average day.
(Hint: a lavatory uses 10 litres per flush, a bath takes about 90 litres, a shower 25 litres, and a washing machine uses 100 litres per wash)

3. Imagine you have been made homeless and live in the emergency camp. Repeat the calculation above and work out how many litres of water you will now need to stay alive each day.

4. There are 2500 homeless people in the temporary camp. How many litres of drinking water in total will be required each day?

5. How many toilets will be required?

Classroom Task 2 – Logistics: Emergency Shelter

You and your partner are **STRUCTURAL ENGINEERS** and have volunteered to go the disaster area. Temporary camps are always a last resort but there is no other option in this case, so you are to be responsible for planning the construction of shelters for the homeless people of the town.

You have just 30 minutes to make your plans!

1. Think about the aftermath of the hurricane. Some buildings may be left standing but can you think of two reasons why they may not be safe to use?

2. Think about what resources (materials, equipment, etc) are needed to build emergency shelters. List four resources that might be available and what you would use them for.

3. Using the camp planning guidelines, if there are 2500 homeless people how many emergency shelters would you build?

4. How much space is needed under cover for the people to shelter?

5. How much total land area is needed for the emergency camp?
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Classroom Task 3 – Logistics: Transportation

You and your partner are **TRANSPORTATION ENGINEERS**. You have flown out to the disaster area to help plan how to get emergency supplies to the people of the town, using the map on page 7.

You have just 30 minutes to make your plans!

1. Think about the aftermath of the hurricane. What transportation problems might there be?

2. If the main road could be repaired, how long would it take a truck, travelling at 40km/hr, to travel from the nearest town to the emergency camp?

3. If you had to collect supplies on foot, how long would it take to walk from the emergency camp to the main road and back again (assuming an average walking speed of 5km/hr)?

4. The bridge on the main road has been washed away. Suggest 3 solutions for transporting supplies across the river

Which of your solutions do you think is the best and why?


Major Road
Minor Road
River
Scale 1cm : 2km
Mountains
Main Town
Emergency
Camp Site
Village
Marsh

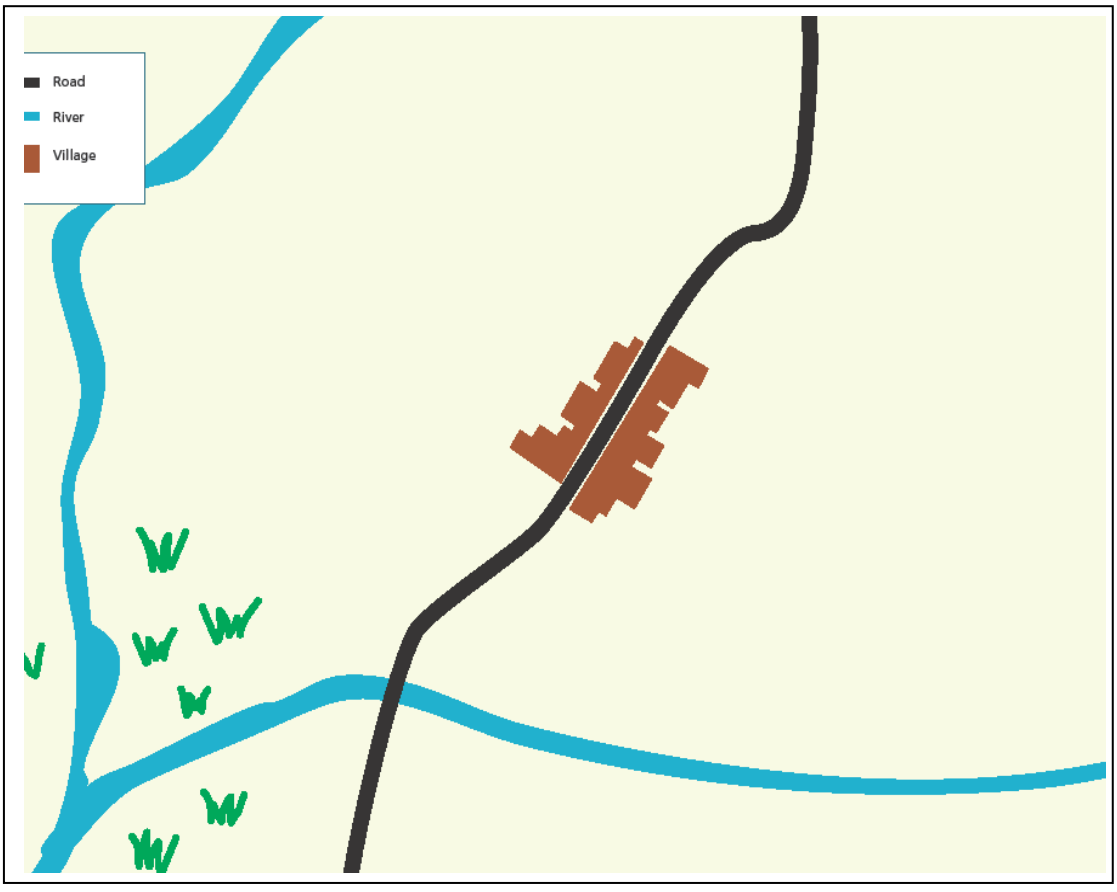
Classroom Task 4 – Presentation to NGO

Your team must now come up with a complete solution for the people of the town and present it to the community and the co-ordinator at the Non-Governmental Organisation.

Create a symbol for each of the items listed below, then mark them on the map in the position you have chosen, showing some dimensions.

After 20 minutes you must be ready to make a presentation explaining the reasons for your solution. This should last 3 minutes and can involve as many members of the team as you choose.

- Emergency shelters.
- Latrines (toilets).
- Clean water supply/collection point.
- Washing area.
- Refuse pits
- Supply route and delivery point



Emergency Camp Planning Guidelines

The ideal site:

- is a flat or gently sloping area, which provides natural drainage. Swamps, river banks or lakeshore sites should be avoided because of the risk of flooding.
- has a clean water supply close enough to avoid pumping or bringing in water by tanker (remember that the weight of one person's daily water needs is ten times the weight of their daily dried food needs).
- has enough space for the number of people - the World Health Organisation recommends an area of 30m^2 per person.
- should be accessible for relief supplies at all times, including during the rainy season.

Sanitation:

- The maximum distance from any household to the nearest water supply point should be 500m
- Toilets - 1 toilet per 20 people is best, with 1 toilet facility shared by 4 or 5 families (better for cleaning & maintenance). Additional toilets will be required for schools, health centres, market places, places of worship etc.
- Pit latrines should be at least 30m from any groundwater source
- All households to have access to a refuse pit no more than 100m away, min of one refuse container per 10 families

Shelter Design:

- There are many different designs of emergency shelter that can be constructed, and the one chosen should make best use of materials that can be salvaged from the surrounding area and use local expertise.
- Shelters should be planned to house family members together.
- Planning guidelines recommend a covered floor area of at least 3.5m^2 per person.

Classroom Task 4 – Presentation to NGO

Spanish

Your team are water engineers working in Honduras. Refugees from the town of Pespire are to be moved to a new camp starting seven days from now. You are responsible for constructing two 45,000 litre water storage tanks in the proposed refugee camp.

Using the instructions provided, prepare a list of key words in Spanish so you can describe the requirements for positioning the water tanks and preparing the ground. The tank kits have been delivered without the required tools (possibly lost in the confusion). Prepare a list of tools for your Spanish speaking colleague to buy in the capital city, Tegucigalpa.

Present your requirements for locating the tanks and preparing the site, plus your list of tools to the class, in Spanish, at the end of the challenge.

French

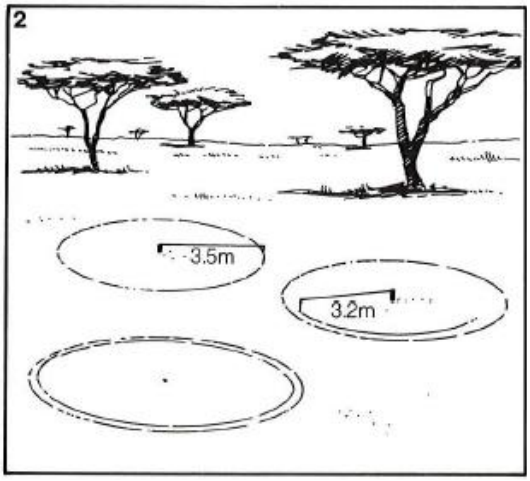
Your team are water engineers working in Haiti. Refugees from the town of Tiburon are to be moved to a new camp starting seven days from now. You are responsible for constructing two 45,000 litre water storage tanks in the proposed refugee camp. Using the instructions provided, prepare a list of key words in French so you can describe the requirements for positioning the water tanks and preparing the ground. The tank kits have been delivered without the required tools (possibly lost in the confusion). Prepare a list of tools for your French speaking colleague to buy in the capital city, Port-au-Prince.

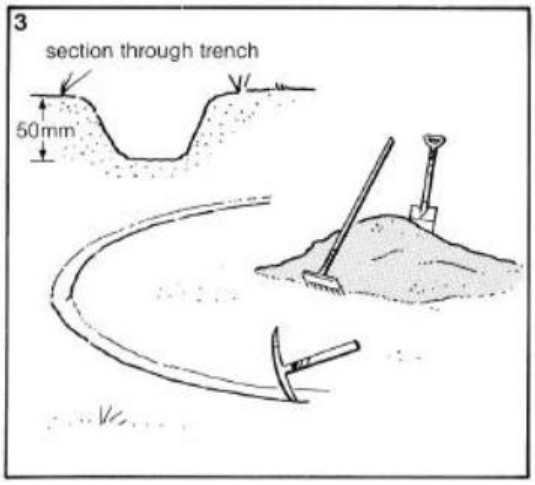
Present your requirements for locating the tanks and preparing the site, plus your list of tools to the class, in French, at the end of the challenge.

Your team must now come up with a complete solution for the people of the town and present it to the community and the co-ordinator at the Non-Governmental Organisation.

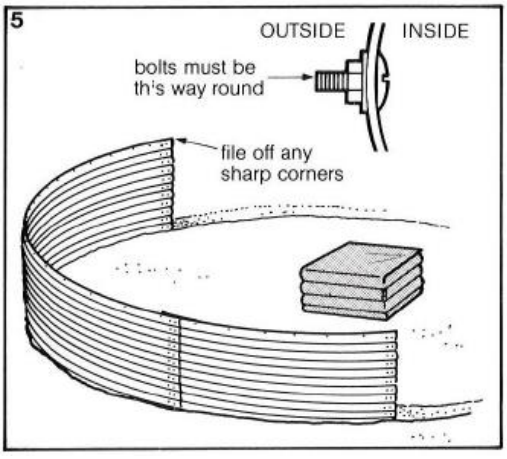
Water Storage Tank Instructions

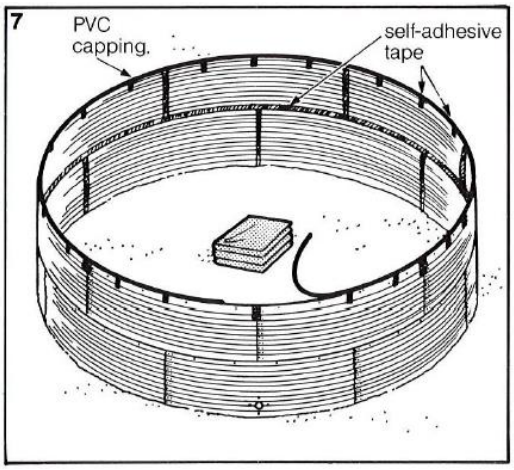
Using a stick and string, mark out circles of 3.5m radius and clear them of vegetation, boulders and stones. Using the same centre, mark out circles of 3.2m radius and dig a trench between these two lines, approx. 50mm deep for the bottom ring of the tank to sit in.
If available, spread a layer of sand 50mm deep in the inner circle to cushion the tank liner.





With one person inside and one outside the ring, stand the first tank wall sheet in the shallow trench and bolt the next one to it, overlapping the sheets and keeping all the boltheads on the inside. Complete the first ruing before installing a second ring on top. Tighten the bolts only when both rings are complete.





Fit the PVC capping around the top and seal the joints with self-adhesive tape.

Classroom Tasks – Answers for teachers

Classroom Task 1 – Water and sanitation

1. drinking, bath/shower, watering garden, flushing toilet, cooking, washing machine, or any other sensible answers

2. 100-500 litres

3. 7.5 to 15 litres

Simplified table of basic survival water needs		
Survival needs: water intake (drinking and	2.5 - 3 litres per day	Depends on: the climate and individual physiology
Basic hygiene practices	2 - 6 litres per day	Depend on: social and cultural norms
Basic cooking needs	3 - 6 litres per day	Depends on: food type, social as well as cultural norms
Total basic water needs	7.5 - 15 litres per day	

4. 18750 to 37500 litres

5. 125

Classroom Task 2 - Logistics: Emergency Shelter

1. Damaged roofs, foundations washed away, unstable walls.

2. Corrugated sheets, wood from upturned trees and ruined houses, plastic sheets, salvaged materials, human resources, flat cleared ground etc.

3. Somewhere in the range of 250 to 500 dependent on the family group size assumed – this must be stated for full points

4. 2500 people x 3.5m²/person = 8750 m² (3.5m²/person is listed in the guidelines for covered area)

5. 2500 people x 30m²/person = 75 000m² (30m²/person is listed in the guidelines as recommended space required)

Classroom Task 3 - Logistics: Transportation

1. Roads washed away or covered by landslides, bridges washed away or damaged and impassable, airport closed due to damage, docks/harbours unusable

2. Dependent on print size, but if A4, approx. distance is 12cm x 2km=24km at speed of 40km/hr, time = 0.6 hours or 36 minutes.

3. Dependent on print size, but if A4, approx. distance is 5cmx2km= 10km at speed of 5km/hr, time = 2 hours.

4. Airlift, temporary bridge, rebuild permanent bridge, raft, boat, etc.

5. Explanation of which is the best option.

Practical activities

There are a number of available activities that can be used, which can be supported by volunteer civil engineers if required. These are not prescriptive and schools are encouraged to develop their own. Instructions for the following activities are included in this document:-

- Water distribution
- Water filtration
- Shelter building
- Bridge building
- Communication tower building

Schools have also developed challenges around first aid including a first aid obstacle course, and challenges relating to food preparation/supply, a water bottle label design for art & design activity and making weather instruments. Details for these are not included as they are not engineering specific.

The following sheets on Pages 15 to 20 are designed to be printed and given to pupils if you are doing all the challenges.

Practical challenge 1 – Build a shelter

Help needed

The hurricane has passed and destroyed most of the houses in the town. It will soon be dark and more rain is expected tonight, so your team must build a shelter. As materials are scarce they have become very expensive; you must try to build your shelter as cheaply as possible, using the materials available to you.

Your task

1. Construct a shelter that can stand up by itself and protect at least one member of your team from the rain - we will test this out with one of you inside!

2. Draw a diagram of your shelter and work out the building costs.

3. Research the requirements for a new emergency shelter camp.

Scoring

Points will be awarded for the cheapest shelters, and also for the shelters which are judged to be the best. This means they must be strong, stable, and weatherproof.

You have just 40 minutes to build your shelter.

Costs of materials

Plastic sheeting (1m x 3m)	**£5 per sheet**
Bricks	**£2 each**
Bamboo canes	**£1 each**
String	**£1 per metre**
Scissors	**£3 per pair**
Sticky tape	**£3 per roll**

These prices may increase as time passes!

Practical challenge 1 – Build a shelter

ENGINEER'S SKETCH - Draw your shelter here.

Calculate the cost of your shelter here

Material	Quantity	Cost
Cost		

Practical challenge 2 - Water supply

Your task

Your team must design and build a water distribution system that will allow water to flow from the storage tank (at bucket 1) to a villager's home (at bucket 2) using only the materials provided.

You have just 40 minutes to build your distribution system!

The Rules

You must not build any part of your system on or over the mountains or the marshes.

You have 40 minutes to build and test your system.

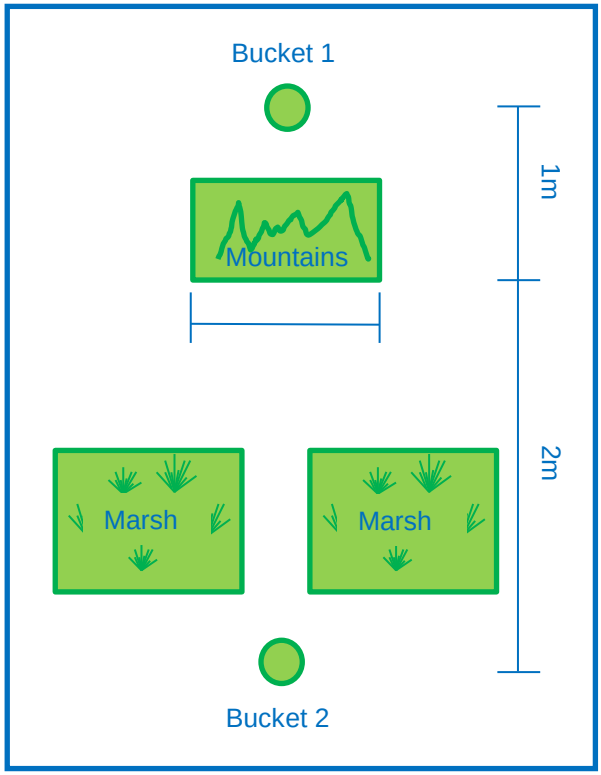
When you think you have completed your structure, you will be allowed one cup of water to test it.

Points will be awarded according to how quickly you can transport water from the tank to the village.

Points will also be awarded for the team who spill least, and end up with the most water in bucket 2 at the end.

During the race you may use only the plastic cups to pour the water into your system. You may not pour directly from the bucket.

All resources must be returned back to their original condition and position otherwise points may be deducted.



Materials

- 10 Bamboo Canes (short, medium & long)
- 4 pipes (1 x 2m; 3 x 1m)
- 5 connectors
- Plastic Cup

Practical challenge 3 – Communication tower

Your team's task is to design, build and test a model of a communications tower to carry a satellite dish that will enable emergency services to be directed more efficiently and save many lives, only the materials provided.

You have 40 minutes to build your system. They will all be tested together at the end.

The Rules

Build a model of a communications tower of no less than 1m in height that will carry a minimum load of 2kg at the top of the tower.

- It must be a free standing structure that will not topple over
- Your model must be at least 1m tall

Practical Challenge 4 – Bridge Building

Your team's task is to design, build and test a model of a bridge to replace the one destroyed by the hurricane, using only the materials provided.

The Rules

Build a model of a bridge that will span the distance given in the plan above and carry a minimum load of 4kg.

- You must **not** build any part of your bridge in the river – it must be a clear span (from river bank to river bank).
- Your model will be built at 1 to 100 scale (i.e. for every 1m in reality, your model will measure 1cm).

You have 40 minutes to build your bridge

Practical Challenge 5 – Water filtration

REMEMBER DON'T DRINK THE WATER - IT IS NOT SAFE!

Resources:

- 2 Litre Bottle
- 150 grams Washed Sand
- 200 grams 4mm Washed Stone
- 200 grams 6mm Washed Stone
- 200 grams 8mm Washed Stone
- Washed moss/clean cloth/coffee filter

Instructions:

1. Measure 120mm up from the base of the bottle and draw a line all the way around. Cut all the way around this line with a pair of scissors (taking care you do not cut yourself on the sharp edge).

2. Place the piece of washed moss/ clean cloth/Coffee filter into the neck of the bottle from the inside. This should prevent the contents from coming out of the bottle.

3. Measure out 150 grams of the washed sand and place it in the bottle on top of the moss/cloth/coffee filter.

4. Measure out 200 grams of the 4mm washed stones and place it in the bottle on top of the sand.

5. Measure out 200 grams of the 6mm washed stones and place it in the bottle on top of the 4mm stones.

6. Measure out 200 grams of the 8mm washed stones and place it in the bottle on top of the 6mm stones.

7. Pass water through the bottle to settle the contents of the bottle. Pour the dirty liquid into the bottle and collect the "clean" water in the base of the bottle.

Appendix 1 – activities resources list per team

Water Distribution Challenge
3no. 2m length half-round gutter
3no. 1.4m length 9mm pine dowel or garden cane
7no. 1m length 9mm pine dowel or garden cane
1 box of elastic bands
2 buckets
6 plastic cups
1 measuring tape
1no. grey ground sheet 1.5m x 0.5m
2no. green ground sheet1m x 0.5m
12no. Tent pegs (if ground sheets used

Shelter Building Challenge
2no. sheets of plastic 1m x 3m
3no. 1.6m length 9mm pine dowel or garden cane
8no. 1m length of 9mm pine dowel or garden cane
1 box of elastic bands
1 bucket

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Water filtration challenge
1 empty 2 litre plastic bottle
Sand
washed 4mm stone
Washed 6mm stone
Washed 8mm stone
Washed moss or clean cloth or coffee filter
Containers for sand & stone
Scoops for sand & stone
Dirty water in container
Cup/jug for pouring water
Pen
Scissors
Measuring tape or ruler

Appendix 1 – activities resources list per team (contd)

Bridge Building Challenge
Dowel for rolling paper around
Measuring tape or metre stick
Roll of masking tape
A4 paper sheets (preferably reused or recycled) or newspaper
A3 paper sheets (preferably reused or recycled) or newspaper
4kg weight & additional weights if testing to destruction

Communication Tower Challenge
Dowel for rolling paper around
Measuring tape or metre stick
Roll of masking tape
A4 paper sheets (preferably reused or recycled) or newspaper
A3 paper sheets (preferably reused or recycled) or newspaper
2kg weight & additional weights if testing to destruction