Catch the Current: Flow Rate Fundamentals

Environmental Scientist Skills

Data Analysis, Field Observation, Risk Assessment

In Lesson 5, an open drainage channel design was introduced for the Mock Site. Flow rates were estimated using Manning's Equation and the Rational Method. You have now been tasked with verifying whether or not the installed Mock Site drainage channel can effectively channel water during standard and extreme rain events.

Part 1: Real-World Performance vs. Theoretical Design

A simple, though imprecise, way to measure velocity of an open channel flow is to place a floating object in the stream at a given point and then time how long it takes to travel downstream. If the water depth of the designed channel during a storm was measured at 1.1 ft the expected flow rate according to Manning's Equation would be **Q =17.15 cfs.**

Determine what the velocity of the flow should be and how long it should take for an object to float ten feet downstream.

V = __________ f/s or _______ seconds to travel 10 feet.

Manning's equation is used to calculate the flow rate of water in open channels:

$$Q = VA \text{ or } V = Q / A$$

A: The cross-sectional area of flow in square feet (ft^2) or (b*y). The designed width of the channel (b) is 3 ft and the depth of water (y) during the storm is 1.1 ft.

If the object were to actually take twice as long to travel downstream, discuss with your team what factors might explain this difference.

Given such a result, would the channel design still be effective at channeling water during the same high storm event where Q = 17.5 cfs? Why or why not?

Part 2: On-Site Rainfall Measurement & Localized Flow

Another way to monitor rain levels is through the use of rain gauges. Engineers often install on-site rain gauges to verify that rainfall intensity matches design assumptions. We will use the following rain gauge reading that was conducted during a theoretical field visit:

Rainfall recorded: 1 inches in 20 minutes

1. Convert this rainfall to inches per hour
   (inches / 20 minutes) x 60 min/hr = _______ in/hr
2. Convert to feet per second:
   _______ in/hr x 0.08 ft/in x .0003 hr/s = _______ ft/s
3. Use the Rational Method: Q = C x A x I = ________ cfs
   - Runoff Coefficient for Paved Areas (C) = 0.9
   - Drainage Area (A) = 20,419 ft^2
   - Storm Intensity (I) = _______ ft/s (calculated in step 1)
4. Based on this calculation, would the channel design still be effective at channeling water during high intensity storm events? Why or why not?

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Dive into Water Quality Analysis!

Environmental Scientist Skills

Sample Collection, Lab Testing, Data Recording

Water quality parameters provide important information about the environmental condition of a water body and can help identify pollutant sources, assess ecosystem health, and guide treatment strategies.

In this activity, we will learn more about chemical and physical quality parameters through hands-on lab work. using the EarthEcho Water Challenge Kit or the mock data cards.

Please reference the provided list of definitions for the various water quality parameters you will be learning about in this lab.

1. Using your knowledge of of chemical and physical water quality parameters, fill in the table on the right:
2. Using either the test kits and site sample or the mock data cards provided by your instructor, to fill in the table below:

Water Quality parameter	Type	What it Tells Us	Why it Matters
pH			
Dissolved Oxygen			
Temperature			
Turbidity			

NOTE: If using the test kits, follow the directions from the kit to test for pH, Temperature, Turbidity, and Dissolved Oxygen

Water Quality parameter	Test Value	Acceptable Range	Notes / Concerns
pH		6.5 - 9	
Temperature (^{o}C)		< 30 C	
Turbidity (JTU)		< 40 JTU	
Dissolved Oxygen (ppm)		> 4 ppm	
Dissolved Oxygen % Saturation			

Based on your test results, which parameters show potential water quality issues? What are some of the possible sources of these issues in an urban area or a school area? What could you and your community do to help improve or protect water quality in your neighborhood and watershed region?

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Streamline Your Strategy

Environmental Scientist Skills

Map Interpretation, Site Selection, Pollution Identification

Your Storm Patrol team has determined the “Where” of your monitoring plan and now you have been asked to finalize the “What”, “When”, and “How” to help assess the impact of your site’s storm water runoff on the nearby stream. Use the Mock Site Sampling Location map to guide these assessments:

1. **WHAT TO ANALYZE**

   Identify the physical, biological, and chemical parameters to analyze.

Physical	Biological	Chemical

2. **WHEN TO SAMPLE**

   Storm water sampling is time-sensitive. Define when the team should deploy for sampling.

   - Qualifying Rain Event: **How much rain must fall before the team deploys? ________ inches**

   - Assess deployment time: Is the goal to capture First Flush or Peak Flow?
     First Flush: The first 30 minutes of runoff often contain the highest pollutant loads.

     Peak Flow: The point of a storm event with the highest rainfall.

     Deploy within ____________ min/hrs of the start of a rainfall event.

3. **HOW TO SAMPLE**

   - Decide if are you taking a grab sample to measure the pollutant level at each specific site, or compositing the three site samples to assess overall site pollution. Circle your choice:

     Grab Samples: *Single containers collected at one specific time.*
     Composite Samples: *Multiple small samples mixed together to show average pollution site-wide.*

   - Write down what equipment you will need in order to collect a sample (e.g. poles, buckets, bottles).

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   - Determine the measurement tools you will need to analyze the target parameters. Circle your choice:
     Field Probes: Instant results or Test Strips/Kits: Fast, semi-accurate results.

Physical	Biological	Chemical
Field Probe or Test Strips/Kit	Field Probe or Test Strips/Kit	Field Probe or Test Strips/Kit

4. WHAT VOLUME IS NEEDED?

- Based on the testing methods for all the parameters, determine the volume of sample needed.

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- What is the total number of samples to be collected from each site?

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5. RECORD & ANALYZE

- Create a log for each sample taken to record: Site ID, Date, Time, Sampler Name, Weather Conditions, and other important information.

Sampler Name		Date		Weather	
Site ID	**Time**	**Temp**	**Turbidity**	**pH**	**DO**

- Create a maximum threshold for your site and an assessment protocol.
  Example: If Turbidity is >50 NTU, we must investigate to determine the source and assess how to limit the polluted runoff.

Parameter	Maximum Threshold	Protocol