CHAPTER 8
Physical Assessment

Introduction
The physical characteristics of a stream will greatly influence what type of aquatic life a stream will support. Within the theatre that is the stream, the physical aspects make up the stage on which all life performs. The stage backdrop of width, depth, velocity, flow, and water temperature influences all of the chemical and biological aspects of the stream.

Weather
Weather may be at times the ONLY thing that matters. For example, a strong four-hour spring rain may result in most of the stream's annual sediment and pollution load. Long-term weather conditions can greatly affect our streams. Floods, droughts, or other climatic extremes can change the stream's physical and chemical characteristics quite dramatically (e.g., creating new stream channels or drainage patterns).

Other ways weather can impact streams are as follows:

- Cloudy weather may result in lower dissolved oxygen levels because of less plant photosynthesis.
- Recent rains reduce point source pollution impacts because of dilution.
- Recent rains increase nonpoint source pollution impacts because of increased surface water runoff and pollutant transport.
- Wind may raise dissolved oxygen levels by increasing turbulence.
- Temperature will affect many parameters, such as the stream's ability to retain dissolved oxygen.

Reporting Technique: Report the weather conditions at the time of your stream assessment. Use the thermometer to measure air temperature before you use it for water temperature. Use your own rain gauge or contact a local radio or newspaper to find out the amount of precipitation during the previous 24-hour period. Web-based resources for precipitation information may also be found at www.iowater.net under the Database menu.

Water Color
The water's color can provide you immediate clues as to a stream's condition. Although clear water may or may not be of high quality, other colors may indicate certain conditions.

Reporting Technique: Estimate water color using these general guidelines.

- **Clear** – Clear water doesn't necessarily mean clean water, but it could indicate low levels of dissolved or suspended substances.
- **Brown** – Brown water is usually due to heavy sediment loads.

- **Green** – Green water is usually the result of excess algae growth.
- **Oily Sheen** – Oily sheens can be caused by petroleum or chemical pollution, or they may also occur naturally as byproducts of decomposition. To tell the difference between petroleum spills and natural oil sheens, poke the sheen with a stick. If the sheen swirls back together immediately, it's petroleum. If the sheen breaks apart and does not flow back together, it is from bacteria or plant or animal decomposition.
- **Reddish** – Reddish or orange colors are usually due to iron oxides.
- **Blackish** – Blackish water is usually is caused by a natural processes of leaf decomposition. Pigments leached from decaying leaves can cause the water to appear murky.
- **Milky** – A milky appearance may be caused by salts in the water.
- **Gray** – Gray water may be a result of natural or human-induced activities.

Water Odor

Water odor, like the water color, can provide immediate clues about potential problems in a stream.

Reporting Technique: Estimate water odor using these general guidelines.

- **None** – The water has no odor
- **Sewage/Manure** – These smells can be common in Iowa's air but should NOT be what our water smells like. It is important to differentiate whether the odor is coming from the water or the air.
- **Rotten Egg** – This odor can be caused by hydrogen sulfide gas, a by-product of **anaerobic decomposition** (rotting without oxygen). This is a natural process that occurs in areas that have large quantities of organic matter and low dissolved oxygen. It may be caused by excessive organic pollution.
- **Petroleum** – Any petroleum or chemical smells can indicate serious pollution problems from a direct source, such as industry or parking lot/storm sewer runoff.
- **Musky** – Musky odors may result from natural or human-induced activities.

Stream Flow

After visiting your site a few times, or by looking closely for high water marks on the land or trees, you will be able to assess stream flow (i.e., whether it's high, normal, or low).

Reporting Technique: Estimate stream flow using these general guidelines.

- High – Stream flow is higher than normal.
- Normal – Stream flow is normal.
- Low – Stream flow is lower than normal.
- Not sure – If normal stream flow is not known, stream flow cannot be estimated.

Stream Width

Stream width is measured from the edge of the water on one bank to the edge of the water on the opposite bank and recorded in meters.

Reporting Technique: To calculate the stream's width:
Facing upstream and starting from the left bank of your *stream transect*, measure the width of the stream in meters with the measuring tape. Make sure to measure the width at the same place each time you assess the stream! To complete stream depth and velocity measurements, you will need to either stake the tape across this stream in this position or monitor with others who can help hold the tape across the stream transect.

Stream Depth

Water depth is important for many fish. Most fish require deeper water areas for over-wintering, and shallow waters are important food production and feeding areas.

Reporting Technique: To calculate a stream's depth:

1. Measure the stream width (see the previous section).
2. Facing upstream and starting from the left bank of your *stream transect*, measure and record the depth of the water in meters at each one-meter increment. Remember to convert centimeters to meters. If your stream is less than two meters wide, measure one spot in the middle.

Maximum Stream Depth

Stream depth is not only important for aquatic life, but it is also important for recreation. Recording maximum stream depth can help provide a more accurate assessment of streams.

Reporting Technique: To calculate maximum stream depth:
Find the deepest spot in the stream along your *transect* and record the depth in meters.

Stream Velocity & Flow

A stream's velocity is a measurement of how fast the water is flowing. This information, along with the stream's water depth and width, is needed to calculate the **flow** (or stream **discharge** rate). This information can help us understand the effects of other parameters.

Reporting Technique: To calculate a stream's average velocity:

1. Measure stream width and depth at your *stream transect* (see the previous sections).
2. Hold the tennis ball (with one-meter string attached) with one hand and the end of the string in the other. Hold both of these directly below the one-meter mark on the tape measure (facing upstream, you should be one meter out from the left bank).
3. Have someone with a stopwatch say "GO," while you release the ball, but continue to hold the string at the one-meter mark.
4. When the ball floats to the end of the string (one meter), stop timing. Record in seconds the time it took the tennis ball to travel the one meter.
5. Repeat the procedure for each one-meter increment. If your stream is less than two meters wide, measure one spot in the middle.

Calculating Stream Flow, Average Depth, and Average Velocity

When stream width, depth, and velocity measurements are submitted to the IOWATER database, average stream depth and velocity, and total flow are automatically calculated for you. During the IOWATER workshops, a number of people have requested that we provide the formulas used for calculating average stream depth, average stream velocity, and total flow. Below are the calculations:

SD = stream depth (meters; SD_1 is the stream depth at spot 1)
1, 2, etc = spots along the stream transect
n = number of spots along the transect
W = width of box at each spot; 1 meter is used
SV = stream velocity (1 meter divided by seconds measured; meters per second)
* = multiplier
÷ = divider

Average Stream Depth (meter)

Average Stream Depth = $[SD_1 + SD_2 + SD_n] \div n$

NOTE: Be sure to convert the measurement from centimeters to meters.

Total Flow (cubic meters per second or m^3/s)

For total flow, imagine a box placed around each spot on your stream transect. A flow is determined for each box and summed for all boxes. Flow associated with each box is calculated by multiplying the width of the box at each spot (1 meter) by stream depth (which you measure) by the velocity of the spot (in the field you measure the number of seconds it takes for the tennis ball to travel one meter; velocity is one meter divided by the number of seconds). The flow of each box is in cubic meters per second (m^3/s). The flow of each box is added together to give total flow.

Total Flow = $(W_1*SD_1*SV_1) + (W_2*SD_2*SV_2) + (W_n*SD_n*SV_n)$

Average Stream Velocity (meters per second or m/s)

Average stream velocity is calculated by dividing total flow by the cross-sectional area of your transect. The cross-sectional area is determined by calculating a cross-sectional area for the box at each spot of your transect and then summing the cross-sectional areas.

Average Stream Velocity = Total Flow $\div[(W_1*SD_1) + (W_2*SD_2) + (W_n*SD_n)]$

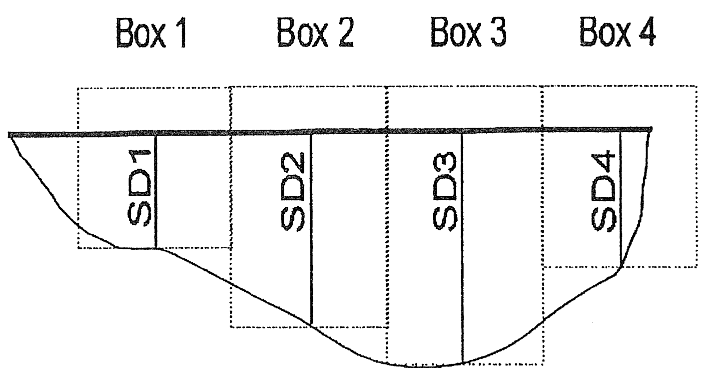
EXAMPLE: Sally and Bill measure stream width, depth, and velocity for Jack Creek. Jack Creek is 4.2 meters wide.

	Stream Depth (meters)	Stream Velocity (meters/seconds)
Spot 1	0.21	1 meter/8 seconds (0.125)
Spot 2	0.45	1 meter/4 seconds (0.25)
Spot 3	0.62	1 meter/3 seconds (0.33)
Spot 4	0.35	1 meter/7 seconds (0.143)

Average Stream Depth = (0.21 m + 0.45 m + 0.62 m + 0.35 m) ÷ 4 = 0.41 m

Total Flow = (1 m * 0.21 m * 0.125 m/s) + (1 m * 0.45 m * 0.25 m/s) + (1 m * 0.62 m * 0.33 m/s) + (1 m * 0.35 m * 0.143 m/s) = 0.39 m^3/second

Average Stream Velocity = Total Flow ÷ Cross-Sectional Area
Average Stream Velocity = 0.39 m^3/second ÷ [(1 m * 0.21 m) + (1 m * 0.45 m) + (1 m * 0.62 m) + (1 m * 0.35 m)] = 0.24 m/s



Cross-sectional view of a stream

Water Temperature

Many of the chemical, physical, and biological characteristics of a stream are directly affected by water temperature. Some species, such as trout, are quite sensitive to temperature changes. Water temperatures can fluctuate seasonally, daily, and even hourly.

Human activities can adversely raise stream temperatures in a variety of ways. **Thermal pollution** can be caused by:

- releasing warmed water into a stream from industry discharges or runoff from paved surfaces
- removing riparian corridors, which increases solar heating
- soil erosion, resulting in darker water, which can absorb more sunlight

Water temperature impacts:

- The amount of oxygen dissolved in water – cool water holds more oxygen than warm water
- The rate of photosynthesis by algae and aquatic plants – the rate of photosynthesis increases with higher temperatures
- The metabolic rates of aquatic animals, which increase with higher temperatures
- The sensitivity of organisms to diseases, parasites, and toxic wastes

Human impacts are most critical during the summer, when low flows and higher temperatures can cause greater stress on aquatic life. It is important to note that the temperature of some streams are normally higher than others, depending on groundwater flow into the stream, weather, and other factors.

Reporting Technique: At your *stream transect* place an aquatic thermometer directly into the stream, holding it underwater in the main flow of the stream (not in a pool) for at least two minutes so the reading can stabilize. Record the temperature on your datasheet.

Instructions for reuniting separated fluid in thermometers: Prepare a solution of shaved ice and salt water. Place the thermometer bulb only into the solution while keeping the thermometer in an upright position. When the liquid column has retreated into the bulb, swing the thermometer with the bulb down in an arc, which will release entrapped gas, permitting it to escape upward in the column. Allow thermometer to warm slowly in an upright position.

Transparency

Transparency is a measure of water clarity and is affected by the amount of material suspended in water. As more material is suspended, less light can pass through, making it less transparent. Suspended materials may include soil, algae, **plankton**, and microbes. Transparency is measured using a transparency tube and is measured in centimeters. It is important to note that transparency is different than turbidity; transparency is a measure of water clarity measured in centimeters, while turbidity measures how much light is scattered by suspended particles using NTUs (Nephelometric Turbidity Units).

Low transparency (or high number of suspended particles) is a condition that is rarely toxic to aquatic animals, but it indirectly harms them when solids settle out and clog gills, destroy habitat, and reduce the availability of food. Furthermore, suspended materials in streams promote solar heating, which can increase water temperatures (see *Water Temperature*), and reduce light penetration, which reduces photosynthesis, both of which contribute to lower dissolved oxygen. Sediment also can carry chemicals attached to the particles, which can have harmful environmental effects.

Sources of suspended particles include soil erosion, waste discharge, urban runoff, eroding stream banks, disturbance of bottom sediments by bottom-feeding fish (carp), and excess algal growth.

Reporting Technique:

1. Make sure the finger clamp on the hose is closed. Facing upstream, in the area along your *transect* with the greatest flow, fill the transparency tube.
2. Hold the tube upright and in the shade. Use your body to shade the tube if nothing else is available.
3. With your back to the sun, look directly into the tube from the open top and release water through the small hose, regulating the flow with the finger clamp until you are able to distinguish the black and white pattern (Secchi pattern) on bottom of the tube. Close the finger clamp.
4. Read the number on the outside of the tube that is closest to the water line. Record your reading in centimeters (cm).

*Note – Rinse the tube after each use so that the bottom Secchi pattern does not become dirty and clouded.

IOWATER

Volunteer Water Quality Monitoring

Physical Assessment

*** Recommended frequency – monthly ***

Date ________ **Time** ________

IOWATER Monitor ________________ **# of Adults** (*incl. you*) ______

Site Number ________________ **# of under 18** ______

Other Volunteers Involved ______________________

Was the stream dry when it was monitored? Yes _____ **No** _____

Weather (*check all that apply*)
Sunny ____ Partly Sunny ____ Cloudy ____ Rain/Snow ____ Windy ____ Calm ____

Water Color (*check all that apply*)
Clear ___ Brown ___ Green ___ Oily ___ Reddish ___ Blackish ___ Milky ___ Gray ___

Water Odor (*check all that apply*)
None ___ Sewage/Manure ___ Rotten Eggs ___ Petroleum ___ Musky ___

Air Temperature ______ °Fahrenheit

Precipitation ______ inches over the last 24 hours

Transparency (*record whole numbers only – no tenths*)
________ centimeters

Water Temperature
______ °Fahrenheit

Stream Width
____.____ meters

Maximum Stream Depth (*along your transect*)
____.________ meters

Stream Flow (*along your transect*)
_______ high _______ normal _______ low _______ not sure

Stream Depth (*in meters*)

1st Spot ____.______	5th Spot ____.______	9th Spot ____.______	13th Spot ____.______
2nd Spot ____.______	6th Spot ____.______	10th Spot ____.______	14th Spot ____.______
3rd Spot ____.______	7th Spot ____.______	11th Spot ____.______	15th Spot ____.______
4th Spot ____.______	8h Spot ____.______	12th Spot ____.______	

Stream Velocity (*in seconds*)

1st Spot ______	5th Spot ______	9th Spot ______	13th Spot ______
2nd Spot ______	6th Spot ______	10th Spot ______	14th Spot ______
3rd Spot ______	7th Spot ______	11th Spot ______	15th Spot ______
4th Spot ______	8th Spot ______	12th Spot ______	

Other Stream Assessment Observations and Notes

____

____

____

____