Discrete Water Quality – Taking Black Disc Readings (Visual Clarity)

1. Overview:

Horizons Regional Council's (HRC's) discrete water quality sampling programme(s) require the field assessment and recording of visual clarity at surface water State of Environment (SoE) and Point Discharge sample sites (excluding discharge/waste effluent sites). HRC uses two methodologies for measuring visual clarity; black disc and clarity tube. Of the two, the black disc method is the primary method. The secondary method is a clarity tube measurement detailed in 15.6 Appendix 10 of the Hydrology Ops Manual.

This iteration of the SOP complies with the requirements set out within the National Environmental Monitoring Standards (NEMS): Water Quality; Part 2 of 4 (March 2019). This SOP outlines the correct use of the black disc equipment and the recording of black disc data.

2. Equipment required:

1. Tape/Tag line
2. Viewer Box – complete with mirror and canvas cover
3. Black Disc – comprising of a frame with 3 screw on discs (20mm/60mm/200mm)

Figure 1: Black disc equipment (HRC)

- The black disc viewers and disc sets are stored in the water quality lab.
- These are to be used in matching sets as labelled (i.e. BD3)
- Check the equipment prior to leaving the office:
  (i) Discs – all three are present and screw/unscrew from the frame,
  (ii) Disc frame is free from chips/exposed metal (this can lead to bias),
  (iii) Disc frame and viewer are tagged and of a matching set,
  (iv) Viewer box has its canvas bag/cover,
  (v) Viewer box is complete with mirror,
  (vi) Viewer box lens is devoid of any major damage. *If damage is present inform the discrete water quality portfolio holder ASAP.*
- Make sure that you have towels to remove any condensation from the viewer during your sampling run.
- The viewer box should only be out of its protective cover for either taking measurements or inspection.

3. Use of Black Disc:

The back disc methodology is HRC's primary water clarity method. However, the feasibility of using the black disc method varies according to both site and flow conditions. In such situations, the clarity tube is to be used in lieu of the black disc as detailed in 15.6 Appendix 10 of the Hydrology Ops Manual.

The safety of staff remains the priority in all field activities and the hazards of using the black disc should always be assessed prior to undertaking. In addition, some conditions may result in a bias when using this

method. Examples of typical situations where the clarity tube should be used in lieu of black disc are listed below:

(i) flow conditions do not allow the safe undertaking of black disc measures (i.e. high flow events),
(ii) site conditions do not allow the safe undertaking of black disc measures (i.e. water depth and access constraints),
(iii) flow conditions are not suitable for black disc measurements (i.e. very low velocity sites combined with fine bed material causing bias).

In addition, when the visibility range is 0.02 to 0.5 meters the clarity tube may be used in place of the black disc as per the National Environmental Monitoring Standards.

The same method (black disc or clarity tube) should be used at upstream and downstream sites where possible, for example at sites upstream and downstream of a STP.

4. Taking a Black Disc reading:

4.1 Site Selection:

Care should be taken to maximise staff safety and avoid bias; therefore, site selection needs consideration.

- Ensure the site is safe prior to entering; in terms of velocity, access and visibility (refer to HMP18) – if in doubt select another site or use a clarity tube (refer to 15.6 Appendix 10 of the Hydrology Ops Manual).
- Select an undisturbed run within the immediate reach of the sample site.
- The site should be representative of the sample location (i.e. hydrologically the same).
- The site should ideally be upstream of any other activity that may disturb the streambed.
- The site should have a reasonable flow, greater than 0.1 m/s, but not exceeding 1 m/s (i.e. unsafe), to ensure that disturbed particles flow out of the viewing area reasonably quickly.
- The site should ideally have reasonable depth in order to completely submerge the black disc(s).
- Ensure that there are no interfering objects behind the black disc (to a distance of at least 50% of the recorded black disk distance).
- Avoid partial shadowing – the path of sight should be either uniformly sunlit (recorded on the field form as SUN) of uniformly in shadow (recorded on the field form as SHADE). *If partial shadowing is unavoidable, add this to the comments section of the field form*.

4.2 Deploying the Black Disc:

- Position the disc in the steam by placing it onto the steam bed. Use cobbles and bed material to hold the frame in place in faster flows.
- The direction of sighting onto the disc in relation to current is not typically important. Although the disturbance caused by plumes of fine sediment may clear more quickly from the path of sight when viewed cross-current. *Avoid sighting toward direct sunlight.*

4.3 Black Disc Selection:

The correct disc size is used to keep the apparent size of the disc near constant in the *'optically large' range of 1-10º of arc*. This correlates to the following ranges:

Disk size (diameter)	Visibility range
200 mm	> 1.5 m
60 mm	> 0.5–1.5 m
20 mm	0.1–0.5 m
SHMAK tube (20 mm diam.)	0.02–0.5 m

Table 1: Black disc size criteria (Table 3: National Environmental Monitoring Standards: Water Quality; Part 2 of 4 (March 2019)).

The individual discs themselves can be screwed to the metal frame accordingly - this may require an initial sighting to ensure that the appropriate disc is selected.

4.4 Taking a Black Disc Reading:

1. Place the disc and frame on the bed so that the entire disc is below the surface. Cobbles/bed material may be placed on the base of the frame to hold it in place.
2. Attach the end of the measuring tape to the disc frame hook (alternatively use a tape from the measurement point to the disc).
3. Holding the disc viewer snuggly to your face move away from the disc slowly (and carefully) whilst watching the disc – allow sufficient time for your eyes to adjust.
4. Move away until the disc just disappears from view and record the distance (y1).
5. Move toward the disc until it just reappears and record the distance (y2).
6. The average of y1 and y2 ((y1+y2)/2) is the **horizontal visibility** or horizontal black disc sighting range.
7. Repeat steps 4 - 6 to obtain a **second** **horizontal visibility** value.
8. Record the **average of the two horizontal visibility values**.
9. If the difference between the two horizontal visibility values is greater than 10% measurements should be repeated until a better agreement is made.

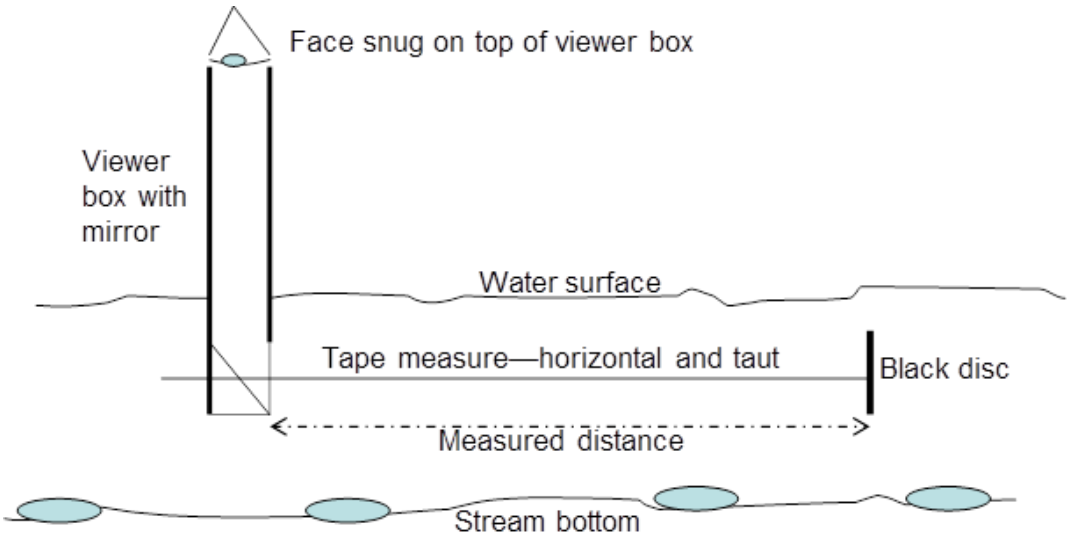

Figure 2. Arrangement for correct measurement of horizontal black disc visual clarity (Source NIWA)

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5. Recording a Black Disc Reading:

All comments written on the Field Sampling Form are entered into Hillltop Sampler verbatim. It is important to comment your findings clearly and legibly.

Black Disk (m) Light conditions	 Sun / Shade

Table 2: Excerpt from field sampling form (HRC)

- On the Field Sampling Form, record the value obtained in Step 8 above to a resolution of 1% (see below table).

Definition of 1% resolution for Black Disc	
observed value:	**recorded to:**
<1m	nearest mm
>1m to <10m	nearest cm
>10m	nearest dm

Table 3: 1% resolution definitions (HRC)

- Record the light conditions during the black disc measurements.
- Record the size of the disc used in the comments section of the Field Sampling Form.
- Poor visibility conditions: In very poor visibility it is not possible to observe very low sighting ranges (i.e. at this distance you are too close to the disc to be able to define its outline), therefore record these occurrences as **<**X.XXm with a supporting comment.
- Obstructions in high visibility conditions: In certain flow conditions and/or channels a high reading is possible, however, the reading may be limited by an in-stream obstruction. In these situations record the black disc value as **>**X.XXm with a supporting comment.

6. Equipment Maintenance:

As per section 2 of this SOP, staff should make equipment checks prior to leaving the office. Documentation, repair and maintenance is the responsibility of the portfolio holder. **If any equipment is either missing or damaged, please contact the portfolio holder as soon as possible. Remove any faulty equipment and take to the portfolio holder's desk ASAP to prevent use. Damaged equipment will affect Quality Coding given to the data.**

As a minimum, the portfolio holder is responsible for the equipment to be:

- Documented in Environmental Data's Asset Database
- Prevented from use by staff if in need of repair, damaged or if incomplete
- Maintained in appropriate condition
- Stored in a suitable location
- Replaced as and when needed
- Inspected annually as per NEMS.