Form 1221–2
(June 1969)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

MANUAL TRANSMITTAL SHEET

Release 6-50

Date 9/23/75

Subject

6674 - WATER ANALYSIS FOR FISHERIES

1. Explanation of Material Transmitted: This release establishes the Manual section which provides Bureau procedures for collection and analysis of water samples.

2. Reports Required: None.

3. Material Superseded: None.

4. Filing Instructions: After the attached sheets have been filed as directed, this transmittal sheet may be discarded.

REMOVE	INSERT
None	6674

(Total: 13 sheets)

George L. Turcott

Associate Director

6674 - WATER ANALYSIS FOR FISHERIES

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6674 - WATER ANALYSIS FOR FISHERIES

.01 Purpose. This section provides instructions for collection and analysis of water samples as part of the intensive inventory and analysis.

.02 Objective. The objective is to measure existing natural water chemistry, determine productivity and suitablity of water for aquatic life, and identify water pollution sources detrimental to aquatic life.

.03 Authority. (See BLM Manual 6500.03.)

.04 Responsibility. (See BLM Manual 6600.04.)

.05 Definitions. (See Glossary of Terms.)

.06 Policy. It is Bureau policy that collection of water chemistry data be coordinated with other Federal, State, and local agencies to prevent duplication and to employ standard methods of data collection and chemical analysis.

6674 - WATER ANALYSIS FOR FISHERIES

.1 Water Analysis Planning and Preparation.

.11 Water Analysis for Planning and Management Requirements.

A. Stream and Lake Water Analysis is carried out for URA, MFP, and aquatic HMP's.

B. Development Projects and Land Use Activities will be monitored to determine the effect on fish and/or related aquatic organisms.

C. Base-line Water Chemistry. Natural water chemistry must be established and water analysis continued as needed.

D. Wild and Scenic Rivers may require periodic water analysis once the natural water chemistry has been established.

.12 Equipment items required for water analysis and water sample collection are presented as a check list for field trips.

A. Maps of the area to be sampled are needed to record water sample collection locations.

B. Water Analysis Kit is used in the field for physical and chemical water analysis.

C. Water Sample Bottles are provided by certified chemical laboratories for specific analysis. The water analysis kit should have an adequate supply of water sample bottles for field chemical analysis.

D. Thermometer.

1. Pocket Thermometer.

2. Maximum/minimum Thermometer.

3. Reversible Thermometer.

4. Thermograph.

5. Thermister, battery operated.

E. Water Sampler, Tubular. The Kemmerer water sampler is an example of a tubular water sampler used to collect water from various depths in a lake or reservoir.

F. Secchi Disk. To be used for measuring water visibility in lakes and reservoirs.

G. Steel Tape is used to measure widths of streams and other measurements.

H. Depth Sounding Line is used to determine lake water sampling depths.

I. Conductivity Meter is used to measure the conductivity of water in micromohs per centimeter at 25°C.

J. Messenger. A cylindrical shaped metal weight used to release the jaws of a bottom dredge or other spring release sampling device.

.13 Physical Measurements of water include temperature, turbidity, color, volume, suspended and settleable solids, and other parameters.

.14 Chemical Analysis of elements and compounds that affect the living conditions of fish and aquatic life. These include pH, dissolved oxygen, alkalinity, total dissolved solids, heavy metals, pollutants, and others.

.15 Selection of Water Analysis Methods.

A. Chemical Laboratory assistance will be needed for analysis of heavy metals, total dissolved solids, pesticides, and pollutants. The chemist uses established analytical procedures for water analysis and can testify as an expert witness in court. Commercial, county, State, and Federal certified chemical laboratories provide chemical analysis either by fee or cooperative agreement.

B. Water Chemical and Physical Analysis. Field chemical analysis of water samples for temperature, turbidity, dissolved oxygen, carbon dioxide, pH, hardness, ammonia, phosphate, nitrate, and some metals can be analyzed in the field with the water analysis field kit. Water analysis must include the following:

1. Alkalinity, total.

2. Oxygen, dissolved, Appendix,Table II.

3. Temperature, water and air, Appendix, Table III.

4. Turbidity in JTU's, Appendix, Table II.

5. pH, Appendix, Table I.

6. Other chemical analysis can be completed as necessary.

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.16 Sampling Techniques.

A. Streams. The characteristics of the stream and survey objectives will help to determine the number of sample points. Each water sample collected should be representative of existing water conditions in the stream. Special care is required to avoid aeration of samples to be analyzed for dissolved gases such as oxygen, carbon dioxide, or hydrogen sulfide. (See instructions provided with your field kit for dissolved oxygen sampling.) Analysis of dissolved gases should be carried out when the water sample is collected. If sample is "fixed" (see Field Chemical Kit Water Analysis instructions), it can be stored up to 48 hours prior to completion of chemical analysis.

B. Lakes and Reservoirs vary in chemical composition by depth and season of the year. Water samples are collected with a water sampler from a boat or through the ice during the winter months. Sampling procedures are described in Manual section 6672 - Lake and Reservoir Surveys.

.17 Storage and Handling of Water Samples.

A. Labels for Water Samples to be analyzed by a chemist or placed in storage must contain the listed information.

1. Sample or station number.

2. Name of water, stream, lake or reservoir.

3. Time and date of collection.

4. Collectors name and agency.

5. Report of chemical analysis at the collection site.

B. Storage of Water Samples in some containers may alter water chemistry. If the water sample is to be analyzed by a chemist, check for handling instructions, sampling procedures, and water sample bottles to be used.

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.2 Water Chemistry Records.

.21 Water Chemistry Data Sources are U.S. Geological Survey, Environmental Protection Agency, State conservation agencies, State water pollution control commissions, and State health departments.

.22 Recording Water Analysis Data.

A. Stream Water Analysis Data will be recorded on Form 6674-1, Stream Water Analysis Report. See Illustration 1.

B. Lakes and Reservoir Water Analysis Data will be recorded on Form 6674-3. See Illustration 2.

C. Permanent Water Analysis Records. Field records for water analysis of streams, lakes, and reservoirs will be transferred to permanent office records, Form 6674-2, Stream Water Analysis Record (Illustration 3) and Form 6674-4, Lake and Reservoir Water Analysis Record (Illustration 4).

D. URA, MFP, and Aquatic HMP's. Add water analysis data to URA, MFP, and aquatic HMP's as field data collection is made.

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Glossary of Terms

- A -

alkalinity: an expression of the combined bicarbonate, carbonate, and hydroxide ions in natural water.

methyl orange alkalinity: the same as total alkalinity.

phenolphthalein alkalinity: is that fraction of alkalinity contributed by hydroxide and half of the carbonate.

total alkalinity: includes bicarbonates, carbonates, and hydroxide ions.

- B -

biochemical oxygen demand: (BOD) the requirement for oxygen when organic matter decomposes in bodies of water; oxygen demanding wastes lower dissolved oxygen levels in water which in turn can adversely affect aquatic life.

- C -

carbon dioxide: free carbon dioxide is a criterion of environmental quality for fish. High concentrations of carbon dioxide (CO_2) above 25 mg/l are harmful to aquatic life. Most streams have CO_2 concentration of less than 5 mg/l. It is rare to find high carbon dioxide levels in natural waters.

- D -

dissolved oxygen: the dissolved oxygen content of water is an indicator of the biochemical condition of water at that time and place. Fish and other desirable clean water biota require relatively high dissolved oxygen levels at all times. Dissolved oxygen in the range of 7 to 9 mg/l is optimum. Dissolved oxygen levels below 5 mg/l are dangerous to fish. Streams with large loads of organic material may have oxygen consuming and inorganic reactions that deplete oxygen to levels unfavorable for the clean water species. The dissolved oxygen content is an indication of the status of the water with respect to balance between oxygen consuming and oxygen producing processes at the moment of sampling.

- E -

epilimnion: the upper portion of a thermally stratified lake above the thermocline.

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Glossary of Terms

eutrophication: over fertilization of a water body due to increases in mineral and organic nutrients either natural or man-caused, produce an abundance of plant life which uses up oxygen and sometimes creates an environment hostile to higher forms of aquatic animal life.

- H -

heavy metals: metals such as lead, copper, and zinc which are toxic to fish at low levels.

hydrogen ion concentration: see pH.

hypoliminion: that portion of a thermally stratified lake below the thermocline.

- M -

milligrams per liter: mg/l represents the weight of an element dissolved in one liter of water.

- N -

natural water chemistry: the base water chemistry prior to land use and development.

nitrates and nitrites: the nitrogen compounds in natural waters from the fixation of atmospheric nitrogen or from pollution sources. These compounds are available for absorption by bacteria which produce ammonia, nitrite, and nitrate. Inorganic forms of nitrogen are then available as food for phytoplankton. Enormous plant growths do not occur if nitrate nitrogen is below 0.3 mg/l.

- P -

pH: the abbreviation "pH" represents the negative base-10 log of the hydrogenion activity in moles per liter. Stream water in areas not influenced by pollution generally has a pH between 6.5 and 8.5, which is the acceptable range of pH for fish.

phosphates: occur in water as a result of leaching from minerals or as one of the stabilized products of decomposition of organic matter.

p.p.m.: one part per million is equivalent to one milligram per liter.

phytoplankton: floating microscopical plants.

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Glossary of Terms

- S -

saturation values: dissolved oxygen - the amount of oxygen that will dissolve in water is affected by temperatures, elevation, and total dissolved solids. (See "solubility of oxygen", page 480, Standard Methods for the Examination of Water and Waste Water, 13th Edition.)

Secchi disk: a circular metal plate, 20cm. in diameter; the upper surface is divided into four equal quadrants painted with alternating black and white. Used to determine a rough index of visibility in lakes and reservoirs. Not commonly used in streams due to instability of the disk in water current.

specific conductance: Is the measure of the ability of water to conduct an electrical current and is expressed in micromohs per centimeter at 25°C. It can be used for approximating the dissolved solids in water by using the formula:

Specific conductance x (0.65 $\pm$ 0.05)=mg/l dissolved solids.

The formula can be verified by comparison of specific conductance with total dissolved solids determined by a chemist.

- T -

total dissolved solids: (TDS) all of the dissolved material present in natural waters consisting of carbonates, bicarbonates, chlorides, sulfates, phosphates, and other substances. Most productive fresh water has a TDS of about 350 mg/l. The maximum safe level is about 1500 mg/l TDS in fresh water.

thermocline: a layer of water below the eplimnion in which the fall in temperature is very rapid. The upper limit of the thermocline is described as an area where temperature decrease is approximately 1°C per meter or 1°F per foot in depth. Many lakes and reservoirs never become stratified hence a distinct eplimnion, thermocline, or hypolimnion is not present.

thermograph: instrument used to record water temperatures on a continuous basis for long term temperature studies.

thermometer, electric: The electric thermometer can be used to measure water temperature at various depths. A thermometer cord of 100 feet is desirable for lake and reservoir work.

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Glossary of Terms

thermometer, maximum-minimum: temperatures are recorded by leaving the thermometer in the stream. A steel case can be made to cover the thermometer and protect it in the stream bottom.

- W -

water sampler: a tubular sampling device which allows for collection of water samples at various water depths in lakes and reservoirs.

Form 6674-1
(.22A)

6674 - WATER ANALYSIS FOR FISHERIES

Stream Water Analysis Report

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

STREAM WATER ANALYSIS REPORT

Date: 5/21/75
1. Surveyor: Colter
District: Grant
Planning Unit: Shadow Mtn.

2. Stream: Colorado River
a. Tributary to: Sea of Cortez
b. Basin: Colorado River

3. Location (*stream mouth*)
a. Township: 69 N
b. Range: 76 W
c. Section: NW ¼ / SE ¼ Sec. 25

4. County: Grand
5. NUMBER
State Administration Unit: --
Code: --

6. Physical survey data
a. Station number: 1
b. Flow cfs now: 61

c. High
d. Low
e. Time: 1 p.m.
TEMPERATURE °C
f. Air: 61° F
g. Water: 43° F

h. Turbidity (*JTU's*): 0
WATER
i. Color: Clear
j. Odor: None

7. Chemical analysis

Chlorine	Manganese	Phosphate, Ortho
Chromate	Nitrate	Phosphate, Poly
Copper	Nitrite	Silica
Flouride	Oxygen, dissolved 12	Specific conductivity
Hydrogen Sulfide	pH 7.5	Sulfate
Iron	T. Alkalinity 62	

8. Record of sample
a. Shipped to Chemical Laboratory (*location*): U.S.G.S. Denver, Colorado 5/22/75

b. Placed in storage (*location*)

9. Comments:
Weather: Clear and windy, snow melt increasing stream flow.

(Instructions on reverse)

Form 6674-1 (July 1975)

6674 - WATER ANALYSIS FOR FISHERIES

Stream Water Analysis Report

GENERAL INSTRUCTIONS

Stream surveyor completes on site, consolidates, and transfers data to Form 6674–2 at area or District Office.

SPECIFIC INSTRUCTIONS

(Items not listed are self-explanatory)

6. Physical Survey Data – (b) Flow in c.f.s.

R = flow in cfs
W = average width of stream, in feet
D = average depth of stream, in feet
C = a constant for bottom
rough – 0.8
smooth – 0.9
V = velocity in feet/second

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Lake and Reservoir Water Analysis Report

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

LAKE AND RESERVOIR WATER ANALYSIS REPORT

Date 5/23/75

1. Surveyor: Colter
District: Grant
Planning Unit: Shadow Mtn.

2. Lake or reservoir (name)	a. Location (at or near)	b. Basin
Beacon Hill Res.	Greenville	Colorado River

3. Township(s)	Range(s)	Section(s)
2 N	77 and 76 W	12, 7

4. County(ies)	5. NUMBER	
Grand	State Administration Unit	Code

6. Physical and Chemical analysis	a. STATION	
	Number 1	Location Center of W. Arm

b. Time	c. Turbidity (JTUs)	d. Air Temp. °C	e. Secchi Disc Reading
1:30 p.m.	5	(28.4) 83° F	4 ft.

DEPTH (f)	TEMP. °C (g)	DO mg/l (h)	CO_2 mg/l (i)	OTHER ANALYSIS (j)
Surface	20	10	1	
6 M	18	9	1	
8 M	12	8	2	
10 M	6	7	3	
12 M	5	5	4	
14 M	4.2	5	5	
16 M	4.2	4	6	

7. Comments

Thermoline located 6-8 meters

Instructions: Stream surveyor completes on site, consolidates and transfers data to Form 6674-1 at area or District Office

Form 6674-3 (July 1975)

6674 - WATER ANALYSIS FOR FISHERIES

Stream Water Analysis Record

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

STREAM WATER ANALYSIS RECORD

Date 5/21/75

1. Surveyor: Colter

District: Grant

Planning Unit: Shadow Mtn.

2. Stream: Colorado River
   a. Tributary to: Sea of Cortez
   b. Basin: Colorado River

3. Location *(stream mouth)*
   a. Township: 69 N
   b. Range: 76 W
   c. Section: NW ¼/ SE ¼ Sec. 25

4. County: Grand

5. NUMBER
   State Administration Unit:
   Code:

6. Physical survey data
   a. Station number: 1
   b. Flow cfs now: 61

c. High: 240
d. Low: 30
e. Time: 1 p.m.

TEMPERATURE °C
f. Air: 61° F
g. Water: 43° F

h. Turbidity *(JTU's)*: 0

WATER
i. Color: Clear
j. Odor: None

7. Chemical analysis *(mg/l)*

Chlorine	Manganese 16 UG/L	Phosphate, Ortho .0Z
Chromate	Nitrate	Phosphate, Poly
Copper	Nitrite > Combined .01	Silica 14
Flouride .3	Oxygen, dissolved 12	Specific conductivity 140
Hydrogen Sulfide	pH 7.5	Sulfate 9.6
Iron 140 UG/L	T. Alkalinity 62	Total Dissolved Solids 92

8. Record of sample
   a. Shipped to Chemical Laboratory *(location)*: U.S.G.S. Denver, Colorado

b. Placed in storage *(location)*:

9. Comments
   Water Analysis Received 8/1/75, A. J. Carter, Chemist

(Instructions on reverse)

Form 6674-2 (July 1975)

6674 - WATER ANALYSIS FOR FISHERIES

Stream Water Analysis Record

GENERAL INSTRUCTIONS

Stream surveyor completes on site.

SPECIFIC INSTRUCTIONS

(Items not listed are self-explanatory)

6. Physical Survey Data – (b) Flow in c.f.s.

R = flow in cfs
W = average width of stream, in feet
D = average depth of stream, in feet
C = a constant for bottom
rough – 0.8
smooth – 0.9
V = velocity in feet/second

6674 - WATER ANALYSIS FOR FISHERIES

Lake and Reservoir Water Analysis Record

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

LAKE AND RESERVOIR WATER ANALYSIS RECORD

INSTRUCTIONS: Stream surveyor completes on site

Date	8/23/75
1. Surveyor	Colter Colter
District	Grant
Planning Unit	Shadow Mtn.

2. Lake or reservoir *(name)*	a. Location *(at or near)*	b. Basin
Beacon Hill Reservoir	Greenville	Colorado River

3. Township(s)	Range(s)	Section(s)
2 N	77 and 76 W	12, 7

4. County(ies)	5. NUMBER	
	State Administration Unit	Code
Grand		

6. Physical and Chemical Analysis	a. STATION	
	Number 1	Location Center of W. Arm

b. Time	c. Turbidity (JTUs)	d. Air Temp. °C	e. Secchi Disc Reading
1:30 p.m.	5	(28.4) 83° F	4 ft.

DEPTH (f)	TEMP. °C (g)	DO mg/l (h)	CO_2 mg/l (i)	OTHER ANALYSIS (j)
Surface	20	10	1	
6 M	18	9	1	
8 M	12	8	2	
10 M	6	7	3	
12 M	5	5	4	
14 M	4.2	5	5	
16 M	4.2	4	6	

7. Comments

Thermoline located 6-8 meters.

Form 6674-4 (July 1975)

6674 - WATER ANALYSIS FOR FISHERIES

Temperature, pH, and Water Quality for Fish

TABLE I

Hydrogen ion concentrations of natural waters and recommended restrictions on additives.

pH	Moles/liter	Description
4.0	1×10^{-4}	acidic
7.0	1×10^{-7}	neutral
10.0	1×10^{-10}	basic

The Water Quality Criteria Committee (FWPCA 1968, Page 41) recommended that no materials be added to natural waters in quantities sufficient to lower the pH below 6.0 or to raise the pH above 9.0.

The major constituents of most waters are in the concentration range from 10^{-4} moles per liter and up.

At pH 7 (pure water) only 1×10^{-7} moles per liter of hydrogen ion is present.

TABLE II

Summary of fresh water requirements for mixed fish fauna (water quality criteria, McKee and Wolf, 1963)

Parameter	Recommended Maximum/Minimum
Dissolved Oxygen	Not less than 5 mg/l
pH	6.7 to 8.6
Specific Conductivity	At 25°C 150 to 500 Micromohs
Carbon Dioxide	Not more than 3 mg/l
Ammonia	Not over 1.5 mg/l
Jackson Turbidity Units	Not greater than 25 JTU's

6674 - WATER ANALYSIS FOR FISHERIES

Temperature, pH, and Water Quality for Fish

TABLE III

Temperature

Maximum temperatures compatible with the well-being of the various fish species and their associated biota as recommended by the National Technical Advisory Committee on water quality.

93°F: Growth of catfish, gar, white or yellow bass, spotted bass, buffalo, carpsucker, threadfin shad, and gizzard shad.

90°F: Growth of largemouth bass, drum, bluegill, and crappie.

84°F: Growth of pike, perch, walleye, smallmouth bass, and sauger.

80°F: Spawning and development of catfish, buffalo, threadfin shad, and gizzard shad.

75°F: Spawning and egg development of largemough bass, white and yellow bass, and spotted bass.

68°F: Growth or migration routes of salmonids and egg development of perch and smallmouth bass.

55°F: Spawning and egg development of salmon and trout (other than lake trout).

48°F: Spawning and egg development of lake trout, walleye, northern pike, and sauger.

An increase in temperature of a few degrees can upset the natural balance in a stream. The temperatures listed are maximum temperatures not optimum temperatures. Fish and other organisms exposed to maximum temperatures for a long period of time may suffer from unusual stress, disease, and reduced feeding.

6674 - WATER ANALYSIS FOR FISHERIES

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