

Appendix B:
Surface Water Parameters

SURFACE WATER PARAMETERS

The chemical characterization of waterways is important for the general description of water quality conditions yet, it has limitations for making life use attainment decisions. The following parameters are analyzed for violations to the Chapter 93 criteria and will aid in the identification of sources and causes of impairment.

STREAM CLASSIFICATION CODE (Title 25, PA Code)

EV	Exceptional value
HQ-CWF	High Quality Cold Water Fishery
HQ-TSF	High Quality Trout Stocking Fishery
CWF	Cold Water Fishery
MF	Migratory Fishes
TSF	Trout Stocking Fishery

Volume of Flow -

Flow is essential in determining the dilution factor for any potential discharge. It is also an indicator of recent weather patterns. Volumes of flow would be higher than normal after a period of heavy precipitation. This is important because during a test period, which may occur after heavy rains, the quality of the stream may appear degraded due to non-point source runoff. It is also important that the testing period occur during a low flow since pollutants would have the most damaging effect during low flow.

pH -

The pH of a solution refers to its hydrogen ion activity. Measurement of pH is one of the most important and frequently used tests in water chemistry. The pH value of most natural waters falls within the range of 4 to 9. The pH scale ranges from 0 (acid) to 14 (base). The majority of waters are slightly basic because of the presence of carbonates and bicarbonates (generally, salts within the geology). A departure from the normal pH for a particular body of water can be caused by the influx of acid or alkaline industrial wastes. It is a common practice for water treatment plants to adjust the pH. Most fish can tolerate pH values from 5.0 to 9.0, however the best fishing waters fall within the range 6.5 to 8.2.

Specific Conductance - Conductivity is a numerical expression of an aqueous ability to carry an electrical current. It is an indication of the dissolved inorganic solids in the water. The higher the specific conductance, the more impurities are in the water. Freshly distilled water has a conductivity of 0.5 to 2.0 micromhos/cm. The conductivity of the drinking water in the U.S. generally ranges from 50 to 500 micromhos/cm (μS). It is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium and iron.

Biological Oxygen Demand- BOD, is a measure of the dissolved oxygen required for the complete breakdown of organic matter by aerobic bacteria over a five-day period. It is a key criterion used where organic loading must be restricted to maintain desired levels of dissolved oxygen in water. Sources of BOD, in addition to direct loading from WWTPs, include decaying algae, macrophytes and other biota. In streams that are polluted with sewage or high levels of other nutrients, the oxygen use or demand by microorganisms will be high, leaving little oxygen for other aquatic organisms. Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L.

Dissolved Oxygen - D.O. is a measure of oxygen that is dissolved in water. Different levels of D.O. are necessary to support various types of aquatic life. These levels in natural and wastewaters are dependent on the physical, chemical and biochemical activities prevailing in the water body. The minimum D.O. levels are as follows:

HQ-CWF	7.0 mg/l
CWF	5.0. mg/l
TSF	(February 15 th – July 31 st) 6.0 mg/l; Remainder of year 5.0

Temperature - Temperature is essential in determining if acceptable standards exist for a particular stream classification. Elevated temperatures from heated water discharges may have a significant ecological effect. It is also important in determining what the direct effect on fish and other aquatic life will be as a result of temperature fluctuation.

Specific temperature requirements are as follows: There is no instream temperature criterion for any stream that does not have a thermal discharge. The table in § 93.7 is for thermal discharges to streams and indicates the required instream temperature that cannot be exceeded due to the discharge. If there is a thermal discharge to a special protection stream, then the temperature cannot be higher than the receiving water upstream of the discharge (no change in quality is allowed).

Symbol	Protected Water Uses	Specific Criteria	
EV	Exceptional Value	Must maintain Existing Quality	
HQ-CWF	High Quality and Cold Water Fish	7/1 - 8/30	18.9 C (66F)
CWF	Cold Water Fishes	7/1 - 8/30	18.9 C (66F)
TSF	Trout Stocking Fishes	7/1 - 7/31	23.3 C (74F)
MF	Migratory Fishes	8/1 - 8/15	26.7 C (80F)
		8/16- 8/30	30.6 C (87F)

Total Hardness - Hardness is defined as the total amount of calcium and magnesium salts that are present in the water. Hard water aids buffering capacity. Water can be defined by its total hardness as follows:

Soft Water	0 - 60 mg/l
Moderately Hard Water	60 - 120 mg/l
Hard Water	120 - 180 mg/l
Very Hard Water	180 mg/l and up

Total Alkalinity - Alkalinity measures the water's ability to buffer acid or acid neutralizing capacity. It indicates the water's ability to protect fish and other aquatic life against sudden changes in pH. The best fishing waters are those with alkalinity of 100 - 120 mg/l. The minimum level of total alkalinity for aquatic life buffering capacity is 20 mg/l, except where natural conditions are less. Stream alkalinity can be influenced by rocks and soils, salts, plant activities and certain industrial wastewater discharges. Limestone is rich in carbonates and waters flowing through limestone regions or bedrock containing carbonates generally have high alkalinity - hence good buffering capacity. Conversely, areas rich in granites and some conglomerates and sandstones may have low alkalinity and therefore poor buffering capacity.

Total Kjeldahl Nitrogen- T.K.N., is the sum of organic nitrogen and ammonia nitrogen. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H₂SO₄). No numeric standard.

- Nitrogen -** Nitrate plus nitrite as nitrogen. The maximum recommended level for water supply is 10 mg/l as Nitrogen.
- Nitrate (NO₃) -** Nitrate is found only in small amounts in domestic wastewater and is a major ingredient in farm fertilizer. During precipitation events, varying amounts of this chemical wash into nearby waterways. Nitrates stimulate the growth of plankton (tiny animals, plants or bacteria), which provide food for fish. This may cause an increase in the fish population, however, if algae grows too quickly, dissolved oxygen levels in the water will be reduced and the fish may not be able to respire. Because phosphate can be the limiting nutrient for plant growth in many ecosystems, the discharge from a septic tank into the aquatic environment can trigger prolific plant growth including algal blooms. No numeric standard.
- Nitrite (NO₂) -** Nitrite is the intermediate stage between nitrate and ammonia. It is relatively short-lived because it is quickly converted to nitrates by bacteria. Nitrite concentrations in drinking water seldom exceed 0.1 mg/l. No numeric standard.
- Ammonia (NH₃) -** Ammonia is naturally present in surface and ground water and in wastewater. Pure ammonia is strong smelling and colorless. In nature, ammonia is formed by the action of bacteria on proteins and urea. Ammonia concentrations of 0.06 mg/l can cause gill damage in fish; 0.1 mg/l may indicate domestic or agricultural wastes and 0.2 mg/l and above is lethal to trout.
- Total Phosphorous -** Phosphorous occurs in natural waters and wastewaters almost solely in the form of phosphates, and classified as orthophosphates, condensed or organically bound. Phosphates enter waterways from human and animal wastes, phosphate rich rocks, waste from laundries and fertilizer, detritus and the bodies of aquatic organisms. Phosphorous is essential to the growth of organisms and it can be the nutrient that limits the productivity of a body of water. If present in high concentrations in streams, the algae and SAV grow more rapidly, which can choke the waterways and utilize large amounts of dissolved oxygen. Phosphate levels below 0.03 mg/l are generally considered to be unpolluted. The recommended maximum level is 0.1 mg/l for rivers and streams.

Chlorides -	Chlorides are salts that contain chlorine and metal. Common chlorides are sodium chloride, calcium chloride and magnesium chloride. Most good fishing waters have a chloride concentration of less than 170 mg/l. The recommended maximum chloride levels are 250 mg/l for water supply.
Total Acidity -	Acidity can be defined as a solution's ability to neutralize bases. Acidity of water is significant because acids contribute to corrosiveness and influence certain biological processes. Measuring acidity can also reflect changes in the quality of the source water. No numeric standard.
Solids -	The term solids or residue refers to the matter suspended or dissolved in water. Residue may affect water and effluent quality in many different ways. It can affect the palatability of drinking water or the aesthetic quality of bathing waters. For these reasons wastewater treatment processes remove solids from the discharge.
Sulfate	Sulfate (SO ₄) can be found in almost all natural water, with contributions from acid rain. The origin of most sulfate compounds is the oxidation of sulfite ores, the presence of shale or industrial wastes. The maximum recommended value for Sulfate is 250 mg/l.
T.D.S. -	Total dissolved solids (T.D.S.), also termed total filterable residue refers to the portion of residue that passes through a filter of a particular size. The DEP, as well as the EPA, have established secondary maximum contaminant levels of 500 mg/l of TDS for the Commonwealth's drinking water and waterways. The maximum recommended value for T.D.S. is 750 mg/l.
T.S.S. -	Total suspended solids (T.S.S.), also termed total non-filterable residue refers to the portion of residue that cannot pass through a filter of a particular size.
Fecal Coliform -	Coliform bacteria are common in the intestines of both warm and cold-blooded animals and aid in the digestion of food. Some of these coliform bacteria pass out of the body with the stool. Fecal coliform counts of 200/100 mls or less are desirable during summer months (Clesceri et. al, 1998).

Total Organic Carbon – By measuring TOC, the number of carbon containing compounds in a source can be quantified. Significant because the amount identified in a stream can be an indicator of the organic character of a stream. The larger the carbon or organic content, the more oxygen is consumed, thus a high content equates an increase in the growth of microorganisms that could contribute to the depletion of oxygen supplies. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H_2SO_4). No numeric standard.

Calcium - Calcium occurs most commonly in sedimentary rocks in the minerals calcite, dolomite and gypsum. Calcium is an important determinant of water hardness, and it also functions as a pH stabilizer, because of its buffering qualities. Rivers generally contain 1-2 mg/l calcium, in lime areas, rivers may contain calcium concentrations as high as 100 mg/l. No numeric standard.

Magnesium - This element is essential to chlorophyll and red blood cells. Magnesium commonly occurs in the minerals of magnesite and dolomite, contributes to water hardness and is used in alloys, drying agents, fertilizers, pharmaceuticals and foods. No numeric standard.

Oxidation-Reduction Potential (mV)

- a.k.a - Redox Potential - the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Oxidation involves an exchange of electrons between two atoms. The atom that loses an electron in the process is said to be oxidized. The one that gains an electron is said to be reduced. The life expectancy of bacteria in water is related to ORP. In fact, studies have shown that the life span of bacteria in water is more dependent on the ORP value than on the chlorine concentration. ORP describes all chemical reactions in which have their oxidation number (oxidation state) changed. This can be either a simple redox process such as the oxidation of carbon to yield carbon dioxide or the reduction of carbon by hydrogen to yield methane (CH_4). $>400mV$ is harmful to aquatic life.

Table 7. This table describes the chemical parameters detected during the 2009 Water Quality Study. *Meter Malfunction, ND – Not Detected, 0 – No Laboratory

SiteID	SampleDate	StreamName	Volume of Flowcfs	Water Temperature@	Dissolved Oxygen mg/l	pH (Field)	Specific Conductance µS	Total Hardness mg/l	Total Alkalinity (CaCO3)mg/l	Nitrogen mg/l	Nitrate (NO3) mg/l	Nitrite (NO2) mg/l	Ammonia (NH3)mg/l	Total Phosphorous mg/l	Chloride mg/l	Total Acidity (CaCO3)mg/l	TDS (Total Dissolved Solids) mg/l	TSS (Total Suspended Solids)	Fecal Coliform mls	BOD-5	Calcium mg/l	Magnesium mg/l	Total Kjeldahl Nitrogenmg/l	Total Organic Carbonmg/l	Sulfate mg/l	Oxidation Reduction Potential
POCOCR20	9/2/09	Pocono	9.38	12.33	9.96	7.37	111	20	10.5	0.11	0.11	ND	ND	ND	24.3	ND	55	ND	36	ND	ND	ND	ND	ND	ND	152
POCOCR16	9/2/09	Pocono	9.66	12.6	10	7.39	158	32	16.5	0.187	0.187	ND	ND	ND	32.4	ND	79	ND	9	ND	ND	ND	ND	ND	ND	135
POCOCR17	9/2/09	Pocono	14.03	13.83	10.27	7.92	145	36	17	0.227	0.227	ND	ND	ND	32.3	ND	113	ND	9	ND	ND	2	0.787	1.5	5.4	169
SCOTCR04	9/2/09	Scotrun	13.56	14.12	10.41	8.22	220	46	25	0.332	0.332	ND	ND	ND	42.7	ND	110	ND	0	ND	ND	ND	ND	ND	ND	178
POCOCR18	9/2/09	Pocono	83.05	14.67	10.88	7.92	210	46	24	0.426	0.426	ND	ND	ND	40.8	ND	105	ND	36	ND	ND	ND	ND	ND	ND	145
BRODCR01	9/3/09	Brodhead	33.1	13.64	9.2	7.97	79	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	146
DEHOCR04	9/3/09	Devils Hole	9.08	*	*	*	*	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	*
DEHOCR05	9/3/09	Devils Hole	4.93	12.04	9.45	8.02	57	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	136
PARACR08	9/3/09	Paradise	59.24	16.62	0	8.43	148	0	0	0	0	0	0	0	0	0	74	0	0	0	0	0	0	0	0	*
BRODCR22	9/3/09	Brodhead	91.77	15.72	0	8.45	61	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	145
POCOCR14	9/4/09	Pocono	34.4	15.67	9.69	7.84	256	0	0	0	0	0	0	0	0	0	128	0	0	0	0	0	0	0	0	166
RED_RU03	9/4/09	Red Run	0.231	15.97	9.1	10.84	117	30	14	0.459	0.459	ND	ND	ND	35.5	ND	100	ND	18	ND	ND	ND	ND	ND	ND	163
TOBYCR14	9/4/09	Tobyhanna	38.36	18.48	8.81	7.46	109	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	154
TUNKCR03	9/4/09	Tunkhannock	33.72	16.93	9.18	6.17	42	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	186
TUNKCR07	9/4/09	Tunkhannock	4.25	15.28	8.7	6.01	36	20	ND	0.06	0.06	ND	ND	ND	9.4	14	38	ND	27	ND	ND	ND	0.801	5	ND	212
CHERC14	9/8/09	Cherry	9.37	16.96	10	8.42	360	150	106	0.296	0.296	ND	ND	ND	8.51	ND	185	ND	170	ND	40.7	9.61	1.16	1.6	37.3	180
CHERC06	9/8/09	Cherry	9.67	15.89	10.89	8.31	231	114	80	0.307	0.307	ND	ND	ND	7.09	ND	115	ND	140	ND	31.4	7.26	0.667	1.8	30.4	133
BRODCR20	9/8/09	Brodhead	78.2	17.38	11.31	7.97	149	36	17	0.252	0.252	ND	ND	ND	25.9	ND	83	ND	ND	ND	8.77	2.08	0.284	1.2	8.5	0.28
SAMBCR06	9/8/09	Sambo	7.09	16.73	9.58	7.5	311	88	57	2.7	2.69	0.007	0	0.241	36.5	ND	178	ND	1100	ND	28.7	2.9	0.966	2.4	21.5	140
BRODCR16	9/8/09	Brodhead	79.17	17.38	11.31	7.97	149	32	17	0.217	0.217	ND	ND	ND	25.2	ND	86	ND	18	ND	8.4	2.05	0.316	0	8.1	87
CHERC15	9/8/09	Cherry	0.278	16.62	10.34	8.49	270	134	93	0.346	0.346	ND	ND	ND	6.74	ND	163	ND	130	ND	35.6	8.7	0.715	1.1	34.6	135
TOBYCR01	9/9/09	Tobyhanna	16.37	17.56	9.35	7.51	159	29	14	0.255	0.255	ND	ND	ND	32.8	ND	95	ND	ND	ND	7.2	1.89	0.378	4.4	7.6	142
BRODCR13	9/9/09	Brodhead	227	17.7	11.18	8.48	188	50	29	0.385	0.375	0.01	ND	ND	31.2	ND	106	ND	18	ND	14.3	2.47	0.289	1.6	13	134

Table 8. This table describes the chemical parameters detected during the 2009 Water Quality Study. ND – Not Detected, 0 – No Laboratory, W – Winter, R – Replicate.

SiteID	SampleDate	StreamName	Volume of Flow cfs	Water Temperature@	Dissolved Oxygenmg/l	pH (Field)	Specific Conductance μS	Total Hardnessmg/l	Total Alkalinity (CaCO3)mg/l	Nitrogenmg/l	Nitrate (NO3) mg/l	Nitrite (NO2) mg/l	Ammonia (NH3)mg/l	Total Phosphorousmg/l	Chloridmg/l	Total Acidity (CaCO3)mg/l	TDS (Total Dissolved Solids)mg/l	TSS (Total Suspended Solids)mg/l	Fecal Coliform mls	BOD-5	Calciummg/l	Magnesiummg/l	Total Kjeldahl Nitrogenmg/l	Total Organic Carbonmg/l	Sulfate mg/l	Oxidation Reduction Potential
LEHIRI01	9/9/09	Lehigh	37.48	16.33	9.3	7.86	46	24	11	0.108	0.108	ND	ND	ND	17.7	ND	62	ND	36	ND	6.28	1.13	0.382	3.2	4.8	0.382
LEHIRI02	9/9/09	Lehigh	32.69	16.07	9.42	7.35	89	23	10.5	0.143	0.143	ND	ND	ND	17.9	ND	45	ND	18	ND	6.37	1.17	0.351	2.9	5	127
BUCKCR07	9/10/09	Buckwha	15.91	15.79	10.01	7.69	68	40	24.5	0.985	0.985	ND	ND	ND	11	ND	69	ND	36	ND	10.5	2.89	0.346	ND	8.6	164
BUCKCR06	9/10/09	Buckwha	16.21	15.71	9.67	7.62	111	40	23	1.02	1.02	ND	ND	ND	13.1	ND	77	ND	91	ND	10.4	2.71	0.257	1	8	117
TROUCR03	9/10/09	Trout	5.4	18.03	9	7.82	60	27	12	0.108	0.108	ND	ND	ND	14.4	ND	63	ND	ND	ND	7.23	1.26	0.498	5.9	4.3	130
BUCKCR01	9/10/09	Buckwha	9.44	15.51	9.62	7.89	109	40	24	1.05	1.05	ND	ND	ND	12.9	ND	76	ND	160	ND	10.8	2.82	0.305	1.2	7.7	123
BUCKCR08	9/10/09	Buckwha	0.117	17.38	11.31	7.97	149	42	27	0.812	0.812	ND	ND	ND	13.1	ND	77	ND	18	ND	12.7	2.43	0.227	1.5	8.9	145
AQUACR13	9/10/09	Aquashicola	3.66	13.77	10.39	8.02	221	ND	83	0.823	0.823	ND	ND	ND	12.1	ND	133	ND	82	ND	28.6	6.25	ND	1.1	8.8	137
AQUACR11	9/10/09	Aquashicola	0.634	14.04	11.64	8.38	254	118	90	1.12	1.12	ND	ND	ND	16	ND	152	ND	64	ND	33.5	6.83	ND	ND	11.4	100
BRODCR19	9/15/09	Brodhead	290.9	16.23	10.88	7.63	180	44	26	0.335	0.335	ND	ND	ND	29.8	ND	112	ND	73	ND	11.6	2.25	0.278	2.2	10.4	157
MCMICR34	9/15/09	McMichael	175.06	16.09	11.03	7.75	201	51	29	0.401	0.401	ND	ND	ND	31.9	ND	128	ND	270	ND	14.8	2.55	0.245	2.6	12.2	136
BRODCR17	9/15/09	Brodhead	163.6	16.54	11.38	7.65	166	39	23	0.28	0.28	ND	ND	ND	27.3	ND	83	ND	27	ND	10.7	2.07	0.234	1.9	9.1	83
BRODCR18	9/15/09	Brodhead	280.4	16.64	11.7	7.98	193	48	28.5	0.429	0.423	0.006	ND	ND	30.8	ND	97	ND	82	ND	14.1	2.36	0.284	2.4	11.4	110
BRODCR21	9/15/09	Brodhead	218.5	17.07	11.71	8.16	195	50	29	0.416	0.411	0.005	ND	ND	31	ND	124	ND	63	ND	14.4	2.39	0.272	2.5	11.4	78
MARSCR13	9/15/09	Marshalls	23.45	16.75	11.6	8.07	198	69	45.5	0.224	0.224	ND	ND	ND	19.5	ND	133	ND	55	ND	21.5	2.57	0.243	2.4	15.9	107
CHERCR06-W	11/12/09	Cherry	0	8.41	11.08	8.72	201	92	67	0.341	0.336	0.005	ND	0.889	5.85	ND	118	ND	45	ND	24.8	5.62	0.229	1.9	22.9	88
SAMBCR06-W	11/12/09	Sambo	0	8.47	6.86	7.45	231	72	46	1.33	1.33	ND	ND	0.167	26.9	ND	133	ND	130	ND	21.8	2.48	0.318	2.7	15.9	120
RED_RU03-W	11/12/09	Red Run	0	6.44	4.23	7.34	152	24	11	0.5	0.5	ND	ND	ND	33.7	ND	99	ND	180	ND	6.18	1.36	0.331	6	2.7	100
TUNKCR07-W	11/12/09	Tunkhannock	0	5.77	11.41	5.8	43	14	0	0.118	0.118	ND	ND	ND	10.3	ND	45	ND	ND	ND	ND	ND	0.252	5	ND	169
AQUACR13-W	11/12/09	Aquashicola	0	8.93	12.78	8.47	178	72	55	0.713	0.713	ND	ND	ND	13.8	ND	104	ND	ND	ND	ND	4.5	0.673	ND	7.5	104
AQUACR11-W	11/12/09	Aquashicola	0	8.69	12.41	8.74	162	61	42.5	0.628	0.628	ND	ND	ND	15.6	ND	97	ND	18	ND	15.5	3.77	ND	1	7.7	59
BRODCR21-R	9/15/09	Brodhead	0	0	0	0	0	48	28	0.415	0.409	0.006	ND	ND	30.8	ND	131	ND	150	ND	14	2.38	0.334	2.5	11.5	0
BRODCR20-R	9/8/09	Brodhead	0	0	0	0	0	32	17	0.221	0.221	ND	ND	ND	26	ND	87	ND	ND	ND	8.3	2	0.362	1.2	8.3	96
BRODCR19-R	9/15/09	Brodhead	0	0	0	0	0	52	29	0.417	0.417	ND	ND	ND	32.3	ND	130	ND	180	ND	ND	2.61	0.297	2.8	12.1	0
BLANK	11/12/09	BLANK	0	0	0	0	0	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	ND	ND	ND	ND	ND	0.87	ND	ND	0