

## **Water Quality Methods**

### **Measuring Flow**

- Materials needed: one orange, measuring tape and a watch.
- Measure 30 feet of stream length and mark where the measurement begins and ends.
- Take 3 width measurements in this 30-foot length of stream and note the average width.
- Take depth measurements across the width of the stream to obtain the average depth.
- Place orange in stream at beginning of 30-foot measurement and time how long it takes the orange to travel the measured 30 feet.
- Note: If orange becomes stuck or is stalled at any logs or rocks in the stream, the measurement is less valid. If stream is too shallow for an orange to flow, the orange peel will also work.
- Calculate flow as if a meter was used.

### **Creating a Rating Curve**

After the staff gauges are installed throughout the watershed at the thermal project sample sites (summer 2001), a rating curve should be developed. This will enable anyone to estimate the flow of a given stream by checking the stage.

- To create a stage-discharge relationship, the discharge needs to be measured over a wide range of heights (low and high flows). The best way to do this would be to use potentiometer transducers that will measure stage continuously over varying flows. Finally, field volunteers will need to measure discharge periodically with flow meters.
- If transducers are not used, stage measurements need to be taken very frequently by field volunteers.

## **APPENDIX L WATER QUALITY**

**Water Quality Field Data Sheet**

<b>STREAM NAME</b>			<b>LOCATION</b>	
<b>STATION #</b>			<b>STREAM CLASS</b>	
<b>LAT</b>		<b>LONG</b>	<b>RIVER BASIN</b>	
<b>DATE</b>			<b>TIME</b> _____ <b>am</b> _____ <b>pm</b>	
<b>FLOW/STAGE</b>			<b>AGENCY/GROUP</b>	
<b>INVESTIGATORS</b>			<b>FORM COMPLETED BY</b>	
<b>REASON FOR SURVEY</b>				
	<b>CHEMICAL PARAMETER</b>	<b>MEASUREMENT</b>	<b>UNITS</b>	<b>SAMPLING METHOD/INSTRUMENT USED</b>
standard	Temperature			
standard	Specific Conductance			
standard	Dissolved Oxygen			
standard	pH			
standard	Turbidity			
standard	Alkalinity			
standard	Fecal Coliform			
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**§ 93.7. Specific water quality criteria.**

(a) Table 3 displays specific water quality criteria and associated critical uses. The criteria associated with the Statewide water uses listed in § 93.4, Table 2 apply to all surface waters, unless a specific exception is indicated in §§ 93.9a-93.9z. Other specific water quality criteria apply to surface waters as specified in §§ 93.9a-93.9z. All applicable criteria shall be ap-

plied in accordance with this chapter, Chapter 96 (relating to water quality standards implementation) and other applicable State and Federal laws and regulations.

\*Critical use: The most sensitive designated or existing use the criteria are designed to protect.

(b) Table 4 contains specific water quality criteria that apply to the water uses to be protected.

Table 3		
Symbol	Criteria	Critical Use*
Alk	Minimum 20 mg/l as CaCO <sub>3</sub> , except where natural conditions are less. Where discharges are to waters with 20 mg/l or less alkalinity, the discharge should not further reduce the alkalinity of the receiving waters.	CWF,WWF,TSF,MF
Am	The maximum total ammonia nitrogen concentration at all times shall be the numerical value given by: un-ionized ammonia nitrogen (NH <sub>3</sub> -N) x (log <sup>-1</sup> [pK <sub>T</sub> -pH] + 1), where: un-ionized ammonia nitrogen = 0.12 x f(T)/f(pH)f(pH) = 1 + 101.03(7.32-pH) f(T) = 1, T >= 10°C f(T) = 1 + 10(9.73-pH), T < 10°C 1 + 10(pK <sub>T</sub> -pH) pK <sub>T</sub> =, the dissociation 0.090 + constant for ammonia in water. 2730 (T + 273.2) The pH and temperature used to derive the appropriate ammonia criteria shall be determined by one of the following methods: 1) Instream measurements, representative of median pH and temperature—July through September. 2) Estimates of median pH and temperature—July through September—based upon available data or values determined by the Department. For purposes of calculating effluent limitations based on this value the accepted design stream flow shall be the actual or estimated lowest 30-consecutive-day average flow that occurs once in 10 years.	1
Bac <sub>1</sub>	(Fecal coliforms/ 100 ml)—During the swimming season (May 1 through September 30), the maximum fecal coliform level shall be a geometric mean of 200 per 100 milliliters (ml) based on a minimum of five consecutive samples each sample collected on different days during a 30-day period. No more than 10% of the total samples taken during a 30-day period may exceed 400 per 100 ml. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 per 100 milliliters (ml) based on a minimum of five consecutive samples collected on different days during a 30-day period.	WC
Bac <sub>2</sub>	(Coliforms/100 ml)—Maximum of 5,000/100 ml as a monthly average value, no more than this number in more than 20 of the samples collected during a month, nor more than 20,000/100 ml in more than 5% of the samples.	PWS
Ch	Maximum 250 mg/l.	PWS
Col	Maximum 75 units on the platinum-cobalt scale; no other colors perceptible to the human eye.	PWS
DO <sub>1</sub>	Minimum daily average 6.0 mg/l; minimum 5.0 mg/l. For lakes, ponds and impoundments only, minimum 5.0 mg/l at any point.	CWF, HQ-WWF, HQ-TSF
DO <sub>2</sub>	Minimum daily average 5.0 mg/l; minimum 4.0 mg/l. For the epilimnion of lakes, ponds and impoundments, minimum daily average of 5.0 mg/l, minimum 4.0 mg/l.	WWF
DO <sub>3</sub>	For the period February 15 to July 31 of any year, minimum daily average of 6.0 mg/l, minimum 5.0 mg/l. For the remainder of the year, minimum daily average of 5.0 mg/l, minimum 4.0 mg/l. For lakes, ponds and impoundments, the criteria apply to the epilimnion.	TSF
DO <sub>4</sub>	Minimum 7.0 mg/l.	HQ-CWF
F	Daily average 2.0 mg/l.	PWS
Fe <sub>1</sub>	30-day average 1.5 mg/l as total recoverable.	CWF, WWF, TSF, MF
Fe <sub>2</sub>	Maximum 0.3 mg/l as dissolved.	PWS
Mn	Maximum 1.0 mg/l, as total recoverable.	PWS
N	Maximum 10 mg/l as nitrogen.	PWS
OP	Maximum 50 milliosmoles per kilogram.	CWF, WWF, TSF, MF
pH	From 6.0 to 9.0 inclusive.	CWF, WWF, TSF, MF
Phen	Maximum 0.005 mg/l.	PWS
Sul	Maximum 250 mg/l.	PWS
	Maximum temperatures in the receiving water body resulting from heated waste sources regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. Additionally, these wastes may not result in a change by more than 2°F during a 1-hour period.	See the following table.

<i>SYMBOL:</i>	<i>TEMP<sub>1</sub></i>	<i>TEMP<sub>2</sub></i>	<i>TEMP<sub>3</sub></i>
<i>CRITICAL USE:</i>	<i>CWF</i>	<i>WWF</i>	<i>TSF</i>
<i>PERIOD</i>	<i>TEMPERATURE(°F)</i>		
January 1-31	38	40	40
February 1-29	38	40	40
March 1-31	42	46	46
April 1-15	48	52	52
April 16-30	52	58	58
May 1-15	54	64	64
May 16-31	58	72	68
June 1-15	60	80	70
June 16-30	64	84	72
July 1-31	66	87	74
August 1-15	66	87	80
August 16-30	66	87	87
September 1-15	64	84	84
September 16-30	60	78	78
October 1-15	54	72	72
October 16-31	50	66	66
November 1-15	46	58	58
November 16-30	42	50	50
December 1-31	40	42	42

<i>Parameter</i>	<i>Symbol</i>	<i>Criteria</i>	<i>Critical Use*</i>
Total Dissolved Solids	TDS	500 mg/l as a monthly average value; maximum 750 mg/l.	PWS
Total Residual Chlorine	TRC	Four-day average 0.011 mg/l; 1-hour average 0.019 mg/l.	CWF,WWF, TSF,MF

<b>TABLE 4</b>		
<i>Symbol</i>	<i>Water Uses Protected</i>	<i>Specific Criteria</i>
WWF	Statewide list	DO2 and Temp2
CWF	Statewide list plus Cold Water Fish	DO1 and Temp1
TSF	Statewide list plus Trout Stocking	DO3 and Temp3
HQ-WWF	Statewide list plus High Quality Waters	DO1 and Temp2
HQ-CWF	Statewide list plus High Quality Waters and Cold Water Fish	DO4 and Temp1
HQ-TSF	Statewide list plus High Quality Waters and Trout Stocking	DO1 and Temp3
EV	Statewide list plus <b>Exceptional Value</b> Waters	Existing quality

When the symbols listed in Table 4 appear in the Water Uses Protected column in § 93.9, they have the meaning listed in the second column of Table 4. Exceptions to these standardized groupings will be indicated on a stream-by-stream or segment-by-segment basis by the words "Add" or "Delete" followed by the appropriate symbols described elsewhere in this chapter.

### **Existing quality**

(c) The list of specific water quality criteria does not include all possible substances that could cause pollution. For substances not listed, the general criterion that these substances may not be inimical or injurious to the existing or designated water uses applies. The Department will develop a criterion for any substance not listed in Table 3 that is determined to be inimical or injurious to existing or designated water uses using the best available scientific information, as determined by the Department.

(d) If the Department determines that natural quality of a surface water segment is of lower quality than the applicable aquatic life criteria in Table 3, the natural quality shall constitute the aquatic life criteria for that segment. All draft natural quality determinations shall be published in the Pennsylvania Bulletin and be subject to a minimum 30-day comment period. The Department will maintain a publicly available list of surface waters and parameters where this subsection applies, and shall, from time to time, submit appropriate amendments to § § 93.9a-93.9z.

### **Authority**

The provisions of this § 93.7 amended under sections 5(b)(1) and 402 of The Clean Streams Law (35 P. S. § § 691.5(b)(1) and 691.402); and section 1920-A of The Administrative Code of 1929 (71 P. S. § 510-20).

### **Source**

The provisions of this § 93.7 amended through March 8, 1985, effective February 16, 1985, 15 Pa.B. 907; amended March 10, 1989, effective March 11, 1989, 19 Pa.B. 968; amended February 11, 1994, effective February 12, 1994, 24 Pa.B. 832; amended April 3, 1998, effective November 4, 1995, 28 Pa.B. 1633; amended July 16, 1999, effective July 17, 1999, 29 Pa.B. 3720; amended November 17, 2000, effective November 18, 2000, 30 Pa.B. 6059. Immediately preceding text appears at serial pages (258062) to (258064), (243387) to (243392) and (258066) to (258067).

### **Notes of Decisions**

The Department of Environmental Resources is not required to consider the economic consequences to a discharger in establishing water-quality based effluent limitations in a National Pollutant Discharge Elimination System (NPDES) Permit. *Mathies Coal Company v. Department of Environmental Resources*, 559 A.2d 506 (Pa. 1989).

The water quality standards in 25 Pa. Code § 93.7 are to be considered only as one of the major factors in developing discharge limitations, and neither these standards nor effluent limitations based on them in case-by-case DER determinations require a presumption of validity. *Lucas v. Department of Environmental Resources*, 420 A.2d 1 (Pa. Cmwlth. 1980).

### **Cross References**

This section cited in 25 Pa. Code § 93.4b (relating to qualifying as High Quality or Exceptional Value Waters); 25 Pa. Code § 93.8 (relating to development of site-specific water quality criteria for the protection of aquatic life); and 25 Pa. Code § 96.3 (relating to water quality protection requirements).

**§ 93.4b. Qualifying as High Quality or Exceptional Value Waters.**

(a) Qualifying as a High Quality Water. A surface water that meets one or more of the following conditions is a High Quality Water.

(1) Chemistry.

(i) The water has long-term water quality, based on at least 1 year of data which exceeds levels necessary to support the propagation of fish, shellfish and wildlife and recreation in and on the water by being better than the water quality criteria in § 93.7, Table 3 (relating to specific water quality criteria) or otherwise authorized by § 93.8a(b) (relating to toxic substances), at least 99% of the time for the following parameters:

- dissolved oxygen
- aluminum
- iron
- dissolved nickel
- dissolved copper
- dissolved cadmium
- temperature
- pH
- dissolved arsenic
- ammonia nitrogen
- dissolved lead
- dissolved zinc

(ii) The Department may consider additional chemical and toxicity information, which characterizes or indicates the quality of a water, in making its determination.

(2) Biology. One or more of the following shall exist:

(i) Biological assessment qualifier.

(A) The surface water supports a high quality aquatic community based upon information gathered using peer-reviewed biological assessment procedures that consider physical habitat, benthic macroinvertebrates or fishes based on Rapid Bioassessment Protocols for

Use in Streams and Rivers: Benthic Macroinvertebrates and Fish, Plafkin, et al., (EPA/444/4-89-001), as updated and amended. The surface water is compared to a reference stream or watershed, and an integrated benthic macroinvertebrate score of at least 83% shall be attained by the referenced stream or watershed.

(B) The surface water supports a high quality aquatic community based upon information gathered using other widely accepted and published peer-reviewed biological assessment procedures that the Department may approve to determine the condition of the aquatic community of a surface water.

(C) The Department may consider additional biological information which characterizes or indicates the quality of a water in making its determination.

(ii) Class A wild trout stream qualifier. The surface water has been designated a Class A wild trout stream by the Fish and Boat Commission following public notice and comment.

(b) Qualifying as an Exceptional Value Water. A surface water that meets one or more of the following conditions is an Exceptional Value Water:

(1) The water meets the requirements of subsection (a) and one or more of the following:

(i) The water is located in a National wildlife refuge or a State game propagation and protection area.

(ii) The water is located in a designated State park natural area or State forest natural area, National natural landmark, Federal or State wild river, Federal wilderness area or National recreational area.

(iii) The water is an outstanding National, State, regional or local resource water.

(iv) The water is a surface water of exceptional recreational significance.

(v) The water achieves a score of at least 92% (or its equivalent) using the methods and procedures described in subsection (a)(2)(i)(A) or (B).

(vi) The water is designated as a "wilderness trout stream" by the Fish and Boat Commission following public notice and comment.

(2) The water is a surface water of exceptional ecological significance.

#### Authority

The provisions of this § 93.4b issued under sections 5(b)(1) and 402 of The Clean Streams Law (35 P. S. § § 691.5(b)(1) and 691.402); and section 1920-A of The Administrative Code of 1929 (71 P. S. § 510-20).

#### Source

The provisions of this § 93.4b adopted July 16, 1999, effective July 17, 1999, 29 Pa.B. 3720.

#### Cross References

This section cited in 25 Pa. Code § 93.1 (relating to definitions); and 25 Pa. Code § 96.3 (relating to water quality protection requirements).

#### PA Code Chapter § 109.713. Wellhead protection program.

For water suppliers seeking to obtain Department approval for a wellhead protection program, the wellhead protection program shall consist of the following:

(1) A steering committee composed of the necessary representatives, including, but not limited to, the water supplier, local government officials from the affected jurisdictions and potentially affected industry, to designate responsibilities for the planning and implementation of wellhead protection activities.

(2) Public participation and education activities to promote awareness and encourage local support of wellhead protection activities.

(3) Zone II and Zone III wellhead protection area delineation performed in accordance with methodology provided by the Department. Methods applicable to that hydrogeologic setting shall be utilized and site-specific hydraulic and hydrogeologic information shall include, but is not limited to, pumping rate or yield, aquifer properties, water table or potentiometric surface configuration and hydrogeologic mapping.

(4) Identification of existing and potential sources of contamination within each wellhead protection area.

(5) Development and implementation of wellhead protection area management approaches to protect the water supply source from activities that may contaminate the source. These approaches may include, but are not limited to, one or more of the following actions:

(i) Purchase of the wellhead protection area by the water system.

(ii) Adoption of municipal ordinances or regulations controlling, limiting or prohibiting future potential sources of contamination within the wellhead protection area.

(iii) Adoption of municipal ordinances or regulations establishing design and performance standards for potential sources of contamination within the wellhead protection area.

(iv) Transfer of development rights within the wellhead protection area to land outside of the wellhead protection area.

(v) A groundwater monitoring network that serves as an early warning system.

(vi) Public education programs.

(vii) Other methods approved by the Department which will ensure an adequate degree of protection for the source.

(6) Contingency planning for the provision of alternate water supplies in the event of contamination of a well, spring or infiltration gallery and emergency responses to incidents that may impact water supply source quality.

(7) New water supply source siting provisions to ensure the protection of new wells, springs or infiltration galleries.

**Source**

The provisions of this § 109.713 adopted October 7, 1994, effective October 8, 1994, 24 Pa.B. 5175.



## What is GIS?

A geographic information system is a facility for preparing, presenting, and interpreting facts that pertain the earth. This is a broad definition that can be applied to things ranging from hand drawn maps to computer systems to groups of people and animals. In common language, a geographic information systems or GIS is a configuration of computer hardware and software specifically designed for the acquisition, maintenance, and use of cartographic data (Tomlin, 1990, p. xi).

## Vector

Vector is a form of representation, the boundaries or the course of the features are defined by a series of points that, when joined with straight lines, form the graphic representation of that feature. The attributes of features are then stored with a database system. For example, a vector property map of property parcels might be tied to an attribute database of information containing the address, owner's name, property valuation and land use. Vector systems tend to be database management oriented.

## Raster

Raster is the second major form of representation. The graphic representation of features and the attributes they possess are merged into unified data files. The watershed is subdivided into a mesh of grid cells in which we record the condition or attribute of the geography. Raster systems are excellent for evaluating environmental models such as characterization of habitat.

## Shape File

Shapefiles are a simple, non-topological format for storing the geometric location and attribute information of geographic features. The shapefile format defines the geometry and at-

tributes of geographically-referenced features in as many with specific file extensions that must be stored in the same project workspace. They are:

.shp - the file that stores the feature geometry. Required.

.shx - the file that stores the index of the feature geometry. Required.

.dbf - the dBASE file that stores the attribute information of features. Required.

.sbn and .sbx - the files that store the spatial index of the features. Optional. These two files can be created in ArcView. See ArcView's on-line help for more information.

.fbi and .fbi - the files that store the spatial index of the features for shapefiles that are read-only. Optional. These two files can be created in ArcView. See ArcView's on-line help for more information.

.ain and .aih - the files that store the attribute index of the active fields in a table or a theme's attribute table. Optional. These two files can be created in ArcView. See ArcView's on-line help for more information.

.prj - the file that stores the coordinate system information. Optional. This file can be created with and is used by the ArcView Projection Utility. It is not used by ArcView GIS Version 3.x or older versions, or by ARC/INFO versions previous to version 8.0.

.xml - metadata for ArcInfo 8.0, for using shapefiles on the Internet. Optional.

## Grid File

The GRID format is a proprietary ESRI format that supports 32-bit integer and 32-bit floating-point raster grids. Grids are especially suited to

# APPENDIX M ABOUT GIS

representing geographic phenomena that vary continuously over space, and for performing spatial modeling and analysis of flows, trends, and surfaces such as hydrology. With ArcView's Spatial Analyst Extension you can convert themes based on vector features to grids. You can also derive grids from various spatial analysis operations. Grids can be added to views as grid themes. You can classify the grid cells in various ways and choose different colors for each class.

### **TIN (Triangular Irregular Network)**

A TIN is an object used to represent a surface. Since representation of a surface can be done in many different ways, TIN (Triangulated Irregular Network) also implies a specific storage structure of surface data. TIN partitions a surface into a set of contiguous, non-overlapping, triangles. A height value is recorded for each triangle node. Heights between nodes can be interpolated thus allowing for the definition of a continuous surface. TINs can accommodate irregularly distributed as well as selective data sets. This makes it possible to represent a complex and irregular surface with a small data set.

### **What is a DOQ?**

<http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/doq/doq.html>

A Digital Orthophoto Quadrangle (DOQ) is a digital image of the earth's surface that has been digitally scanned and processed to remove the distortion inherent in aerial photography. Using a digital elevation model and advanced image processing techniques, radial and topographic distortion is removed from the image providing a true planimetric product. Basically the DOQ is manipulated to be able to be used with other types of maps and images.

A DOQQ image typically covers one-quarter of a 1:24,000 scale USGS topographic map plus a

little overlap. This type of image is then tiled. The resolution of the image is quite high at one square meter per pixel. As a result of this fine cell size, these images consume large quantities of disk space. To conserve disk space the images are stored in JPEG image format which compresses the data very efficiently. These files can be potentially large and 45 megabytes is not uncommon.

### **What is a DRG?**

<http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/doq/doq.html#DRG>

A digital raster graphic (DRG) is a scanned color image of a U.S. Geological Survey (USGS) standard series topographic map, including all map collar information. The image inside the map neatline is georeferenced to the surface of the earth and fit to the Albers Equal Area Conical projection. The horizontal positional accuracy and datum of the DRG matches the accuracy and datum of the source map.

DRGs are created by scanning published paper maps on high-resolution scanners. The raster image is georeferenced and fit to the UTM projection. Colors are standardized to remove scanner limitations and artifacts. The average data set size is about 6 megabytes in Tagged Image File Format (TIFF) with PackBits compression.

DRGs are stored as rectified TIFF files in geoTIFF format. GeoTIFF is a relatively new TIFF image storage format that incorporates georeferencing information in the header. This allows software, such as ArcView, ARC/INFO, or EPPL7 to reference the image without an additional header or world file.

Much of the GIS information in this document was compiled specifically for the Kettle Creek Watershed from the Pennsylvania Spatial Data Access Internet Web Site at <http://www.pasda.psu.edu> on or before October 15,

2000. This project is relying on the metadata (data about data) that is available on PASDA. There were several pieces of data collected from other sources including the Pennsylvania Bureau of Forestry and Clinton County Planning. The sources are noted in the table of GIS data that is included with the compact disk set. In some cases, existing paper maps were digitally scanned for use as a image that is spatially registered with the watershed. For example, paper Platt Maps were digitally scanned to graphically show property ownership where actual shape themes were not available (e.g. Potter County).

One map projection standard was used to allow for displaying and analyzing the data about Kettle Creek. All spatial data were mapped or converted into the following projection:

Horizontal Coordinate System Definition:

Planar:

Map\_Projection\_Name: Albers Equal-Area Conic

Standard\_Parallel: 40.000000

Standard\_Parallel: 42.000000

Longitude\_of\_Central\_Meridian:  
78.000000

Latitude\_of\_Projection\_Origin: 39.000000

False\_Easting: 0.000000

False\_Northing: 0.000000

Planar\_Coordinate\_Information:

Planar\_Coordinate\_Encoding\_Method:  
Coordinate pair

Coordinate\_Representation:

Abscissa\_Resolution: unknown

Ordinate\_Resolution: unknown

Planar\_Distance\_Units: Meters

Geodetic\_Model:

Horizontal\_Datum\_Name: North American Datum of 1927

Ellipsoid\_Name: Clarke 1866

Semi-major\_Axis: 6378206.4000000

Denominator\_of\_Flattening\_Ratio: 294.98

If the data were not in Albers Equal-Area Conic they were projected into this spatial reference using Arc/Info from Environmental Research Systems Institute, Inc.(ESRI) of Redlands, California. The relevant projection files have been provided on compact disk set in the aml directory and described on the table of all the GIS layers.

All the GIS files were used in ArcView 3.2a from ESRI, Inc. Additional extensions were used including 3D Analyst and Spatial Analyst.

There were additional extensions and patches used that are available from ESRI, Inc. and other web sites. These extensions are freely available from the ESRI web site. These extensions need to be copied into the localdrive/esri/av\_gis30/arcview/ext32 directory in order to be available in ArcView.

## GIS Themes and Legends

For a complete listing of all the GIS data with a brief description of what the theme is about please see the index that is included on the compact disk set. There is also a short PowerPoint presentation that describes what is gis from <http://www.gis.com> included in the compact disk set.