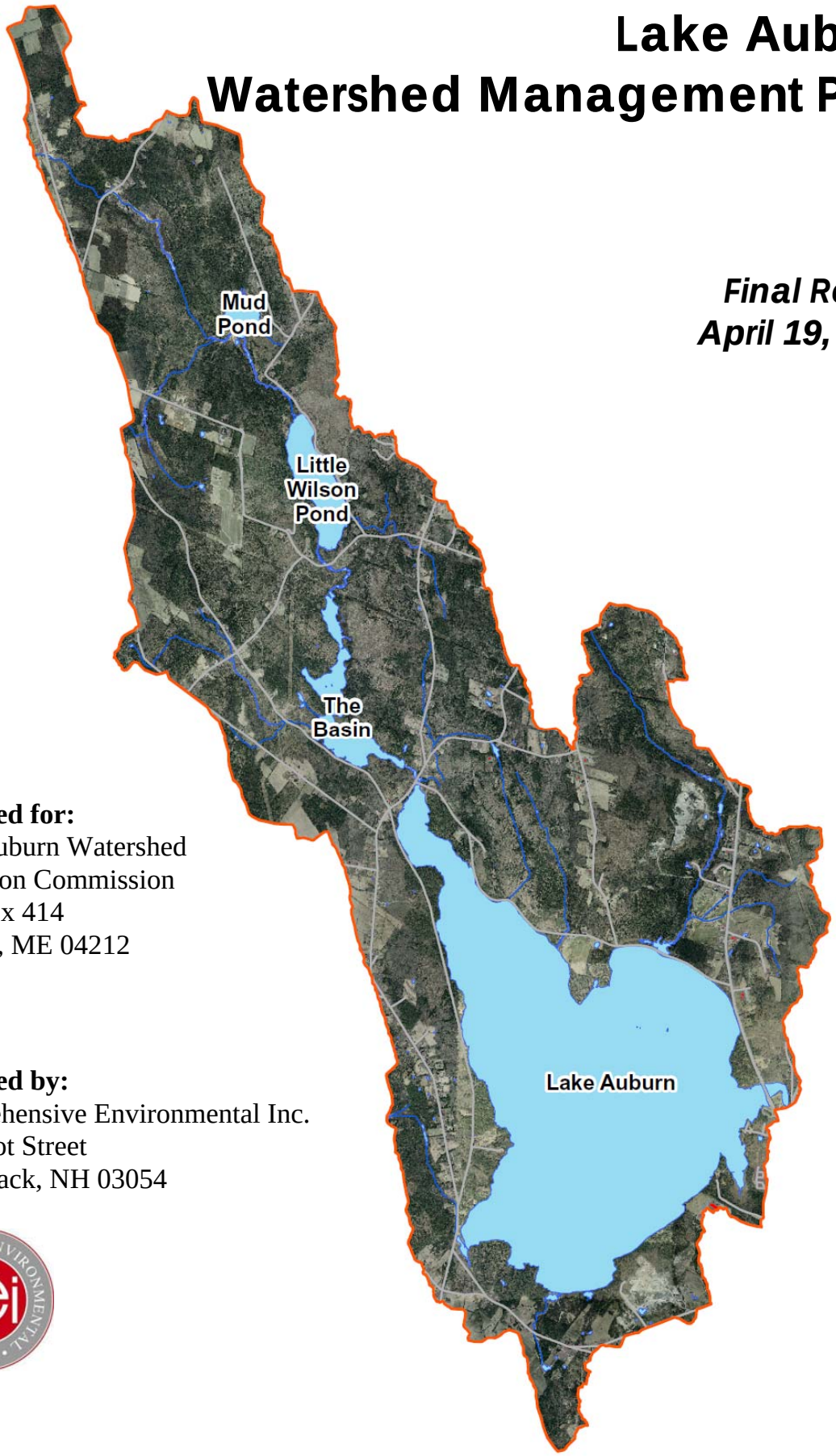
Lake Auburn Watershed Management Plan

Final Report
April 19, 2010



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1.0 Introduction

Lake Auburn, located in Auburn, Maine is the sole drinking water supply for the cities of Auburn and Lewiston, Maine. Due to its excellent water quality and the communities efforts to protect it, the utilities received a waiver from filtration from the State of Maine and U.S. EPA. Through diligent water quality monitoring and an extensive water supply protection program, the utilities have maintained this waiver since 1991, saving water users millions of dollars in treatment and operation costs.

The delivery of safe drinking water is the primary goal of the Cities and of the Lake Auburn Watershed Protection Commission (LAWPC), a commission formed to protect the watershed and water quality of Lake Auburn. To maintain this goal, the LAWPC follows the "Multiple Barrier Approach to Public Health Protection". The "Multiple Barrier Approach" looks at all the components of a drinking water system and identifies safeguards or barriers needed to provide safe drinking water from the source to the consumer at the tap. Recognizing that drinking water is vulnerable to contamination from many potential threats, the 1996 Safe Drinking Water Act Amendments created several requirements and programs to help water systems protect their water supplies and ensure the delivery of safe water to its consumers. These programs and requirements form a Multiple Barrier Approach. This approach focuses on four key barriers:

1. Risk Prevention – Risk prevention focuses on implementing source water protection strategies to prevent contaminants from reaching the source. Protecting the water source is almost always more cost-effective than removing or inactivating contamination that has reached the source through treatment. Watershed management and protection is the primary mechanism for implementing risk prevention.

2. Risk Management – Risk management focuses on providing adequate treatment and system operations to remove any contamination that is present in the source water.

3. Monitoring and Compliance – Monitoring and compliance focuses on testing to detect and fix problems in the source and/or distribution system as early as possible.

4. Individual Action – Individual action focuses on consumer awareness and participation, both about the condition and quality of the source water and of violations that pose health risks.

Continuing to follow this "Multiple Barrier Approach", the LAWPC has developed this update to its 1987 Watershed Management Program to protect the water source in accordance with "Barrier 1 – Risk Prevention". The goal is to maintain the exceptional water quality of Lake Auburn and existing waiver from filtration to avoid or delay the need for costly treatment. The Plan focuses on implementation actions to minimize phosphorus loadings to Lake Auburn from existing and future sources. Phosphorus is the limiting nutrient, or food source, for algal blooms in most fresh water bodies and increasing levels can be correlated with increasing algal blooms. Algal growth can contribute to other water quality problems such as increased turbidity, taste, and odor problems, which may require expensive treatment of the drinking water source.

The Management Plan contains five sections beginning with Section 1.0, which describes the purpose of the plan and describes the Lake and watershed. Section 2.0 describes the source analysis of pollutants using a watershed model developed to evaluate stormwater impacts. Section 3.0 describes the numeric targets or goals for water quality and the reductions necessary to achieve these goals in a predicted buildout scenario. Section 4.0 identifies potential sources of pollution in the watershed. Section 5.0 describes options and control strategies to minimize phosphorus loads, along with the associated cost and schedule.

1.1 Background

Lake Auburn has long been the primary source of water supply for residents and businesses in the Lewiston-Auburn area, currently serving over 45,000 people. The use of Lake Auburn as a water supply began in 1877 and the first water quality protection measures were enacted shortly afterwards with a "No Bathing in the Lake" ordinance.

The Auburn Water District formed in the early 1900s and immediately became involved in the protection of the lake and its watershed to ensure the distribution of clean, healthy water. The Lewiston Water Division later joined these efforts. Protection efforts to date include:

- purchasing land in the watershed, including purchasing key or strategic land parcels in the watershed;
- patrolling the Lake shore;
- conducting reforestation of acquired land;
- maintenance of high lake levels;
- restricting boating and fishing around the intakes;
- adopting the Lake Auburn Watershed Ordinance to seek the placement of controls on the types of development;
- establishing a comprehensive sampling program in and around the lake to monitor water quality trends;
- implementing sanitary inspections for each lot in the watershed;
- maintaining records including sanitary inspections in a database; and
- developing and implementing a Lake Auburn Watershed Study[1] in 1987, which identified the most significant threats to the water supply.

In the 1987 Lake Auburn Watershed Study, recommendations for improvement included:

- amending the ordinance to include additional sediment and erosion control and stormwater control provisions, to prohibit certain land uses within the watershed, to prohibit certain uses of the lake;
- establishing a committee for implementation of agricultural best management practices (BMPs);
- continuing a public education program;
- implementing a sanitary inspection program and incorporate into ordinance;

[1] Camp Dresser & McKee Inc., Final Report Lake Auburn Watershed Study, December, 1987.

- implementing a long-term water quality monitoring program;
- closing the Gracelawn Landfill;
- conducting a study of The Basin; and
- establishing a Lake Auburn Watershed Commission.

In 1991, the Cities of Auburn and Lewiston received a waiver from filtration from the State of Maine and U.S. EPA, at a time when these agencies originally required filtration of most surface water systems. The Cities obtained this waiver due to Lake Auburn's uniquely pristine water with high clarity and very low levels of phosphorus, pathogen and other pollutants and the Cities' programs to control detrimental activities occurring in the watershed. These programs included the ordinances in place specific to the Lake Auburn Watershed and implementation of the 1987 Lake Auburn Watershed Study.

The Cities have since implemented the recommendations of the 1987 study, including the formation of the Lake Auburn Watershed Protection Commission (LAWPC) in 1993. The mission of the LAWPC is to maintain safe and healthful environmental conditions within the Lake Auburn Watershed, to prevent and control water pollution and to protect and maintain the present quality and volume of potable water supplied from the Lake Auburn watershed. Recognizing the importance of watershed protection to maintain the filtration waiver, the LAWPC has initiated an effort to update the 1987 Lake Auburn Watershed Study to reevaluate and reprioritize its efforts. Since watershed management is always a work in progress, it is helpful to complete periodic updates and adjust methods, goals and actions to match the latest scientific understanding of the best watershed management techniques. This report presents the update completed in 2010.

1.2 Purpose of the Watershed Management Program

This Watershed Management Plan provides an update and reevaluation, in conjunction with the City of Auburn Master Plan Update, of the watershed protection efforts performed by the Auburn Water District, Lewiston Water Division and Lake Auburn Watershed Protection Commission (LAWPC). The quantitative evaluation of existing and potential future sources of pollution included the development of a computer model of the Lake watershed. This model also helped determine how proposed watershed protection measures would affect the total pollution load. The objectives of the evaluation include:

1) identifying water quality goals based on the most recent water quality data;
2) calibrating the data to match observed pollutant concentrations in Lake Auburn; and
3) matching proposed future projects to the water quality goals for the watershed.

The following sections present the findings, modeling results and actions proposed for maintaining water quality in Lake Auburn. Consistent use of quantified loadings provides a basis to evaluate the effectiveness of projects towards achieving water quality goals.

1.3 Description of the Lake and Watershed

Lake Auburn is located in the City of Auburn in central Maine as shown in Figure 1-1. Several perennial tributaries feed the Lake, including:

- The Basin outlet, which drains a chain of ponds in the northwestern half of the Lake Auburn watershed including The Basin, Little Wilson Pond and Mud Pond;
- Townsend Brook;
- East Unnamed Brook at Lakeshore Drive;
- Unnamed Brook at Johnson Road; and
- West Unnamed Brook at Lakeshore Drive.

Bobbin Mill Brook is the sole outlet from the Lake (excluding water supply withdrawals). The ponds in the northwestern half of the watershed comprise approximately 240 acres of water surface area, while Lake Auburn has a mean surface area of 2,260 acres or 3.53 mi^2 (square miles).[2]

Lake Auburn has a mean depth of 40 ft (feet), a maximum depth of 120 ft and an approximate volume of 3,920 million ft^3 (cubic feet).[2] The Lake is generally stratified May through October with an average thermocline between 20 and 30 feet in spring (May), between 23 and 36 feet in summer (June through August) and between 43 and 49 feet in fall (September through October). Little to no stratification is generally observed November through April, however stratification can still occur during these periods with the right conditions. The estimated Lake flushing rate is about 4.1 years based on average inflows from streams and precipitation. Table 1-1 provides a summary of the Lake and watershed morphological data.

Table 1-1. Lake Auburn Morphometric Data

Surface Area	2,260 acres	USGS, 2004
Maximum Depth	120 ft	USGS, 2004
Mean Depth	40 ft	USGS, 2004
Volume	3,920 million ft^3	USGS, 2004 (3,570 million ft^3 calculated by CEI using bathymetric data provided by the Auburn Water District)
Watershed Area	9,651 acres	Measured from GIS, excluding Lake Auburn Area
Shoreline Length	67,531 feet	Measured from GIS

The Lake Auburn watershed occupies about 9,650 acres of land and water (excluding Lake Auburn) in five central Maine cities and towns including Auburn, Turner, Minot, Hebron, and Buckfield. The land area alone, excluding all ponds and lakes comprises about 9,413 acres. Figure 1-2 shows the watershed and city and town boundaries. The watershed is lightly developed with a mix of forested area, hay/pasture, wetlands, low-intensity development, high-intensity development and cropland. Over the years, the Auburn Water District, Lewiston Water

[2] USGS (2004), *Water Budget for Lake Auburn, Maine, May 1, 2000 through April 30, 2003*, (Scientific Investigations Report 2004-5106), Augusta, Maine: USGS.

Division and LAWPC have acquired shoreline property within the watershed as it has become available. As a result, the District or LAWPC owns about 81% of the Lake Auburn shoreline and about 1,320 acres (14%) of the Lake Auburn watershed. Total protected lands in the watershed, including conservation easements, comprise about 1,975 acres or 21% of the watershed. Figure 1-3 shows these protected lands.

The Lake tributaries were used to divide the watershed into 13 major subwatersheds, as shown in Figure 1-4, listed roughly from north to south:

- Mud Pond;
- Little Wilson Pond;
- The Basin;
- North Auburn;
- Spring Road;
- Lake Shore Drive, West;
- Lake Shore Drive, East;
- Townsend Brook;
- West Auburn Road;
- Route 4;
- Youngs Corner; and
- Summer Street.

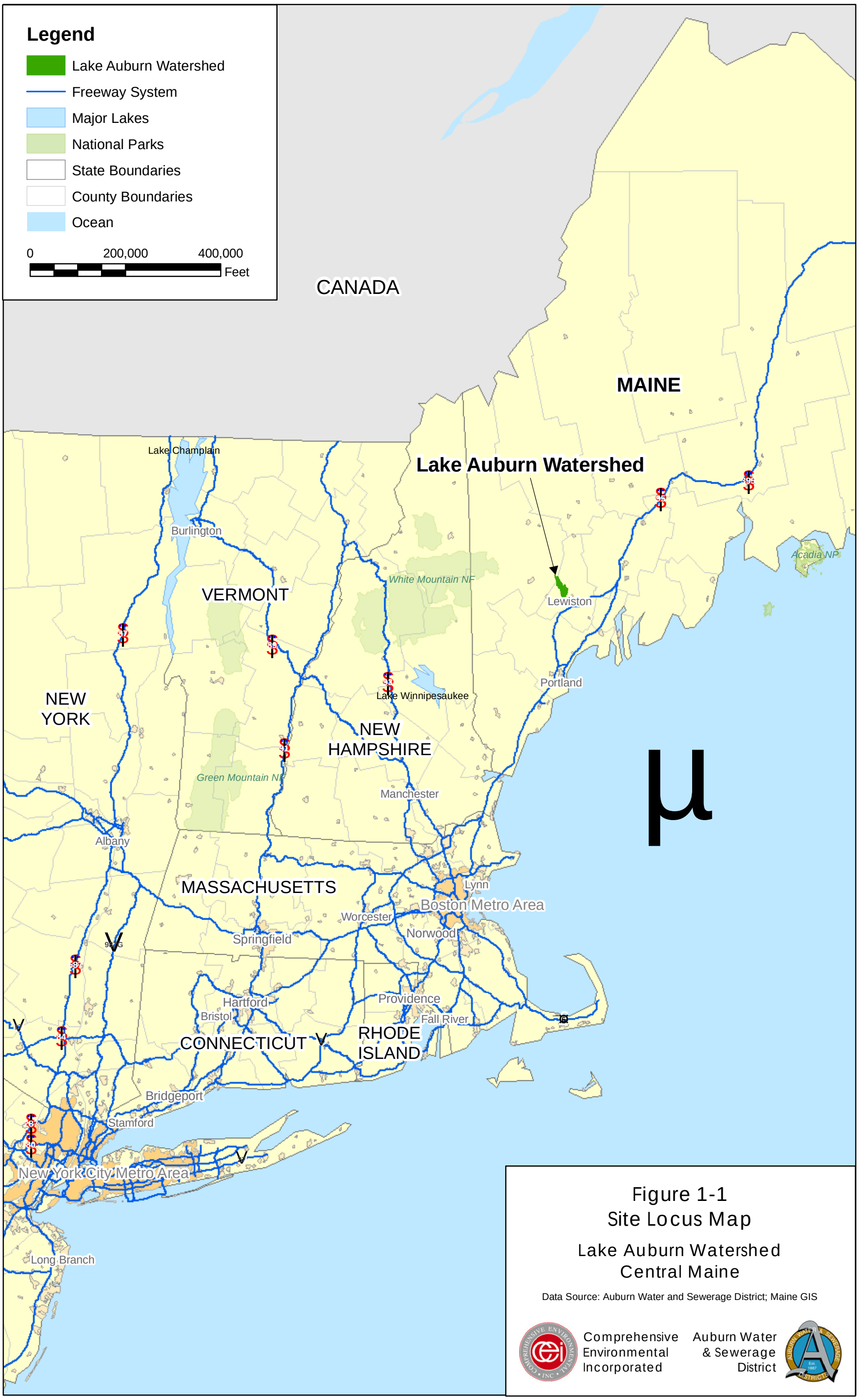


Figure 1-1
Site Locus Map

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

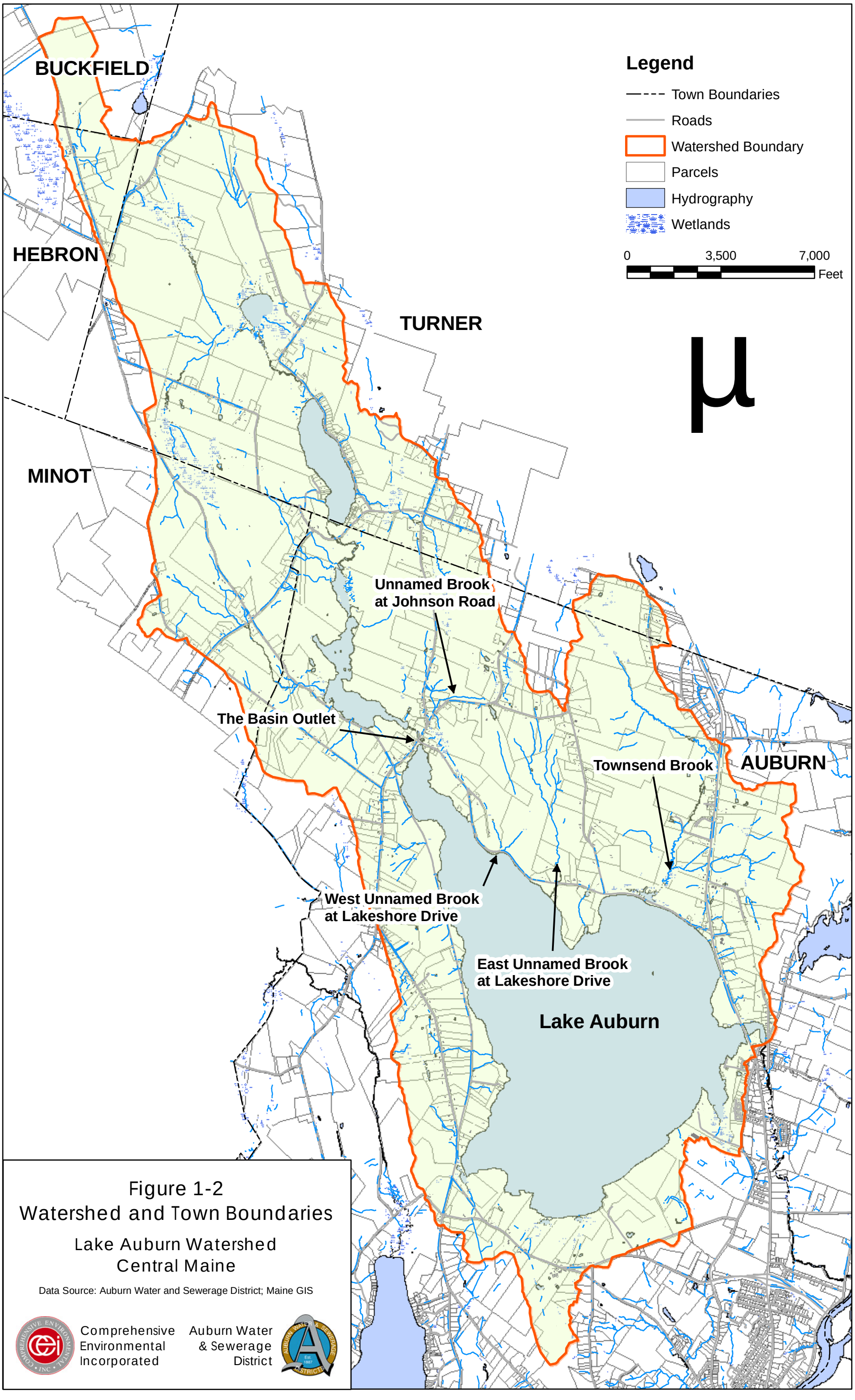


Figure 1-2
Watershed and Town Boundaries

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

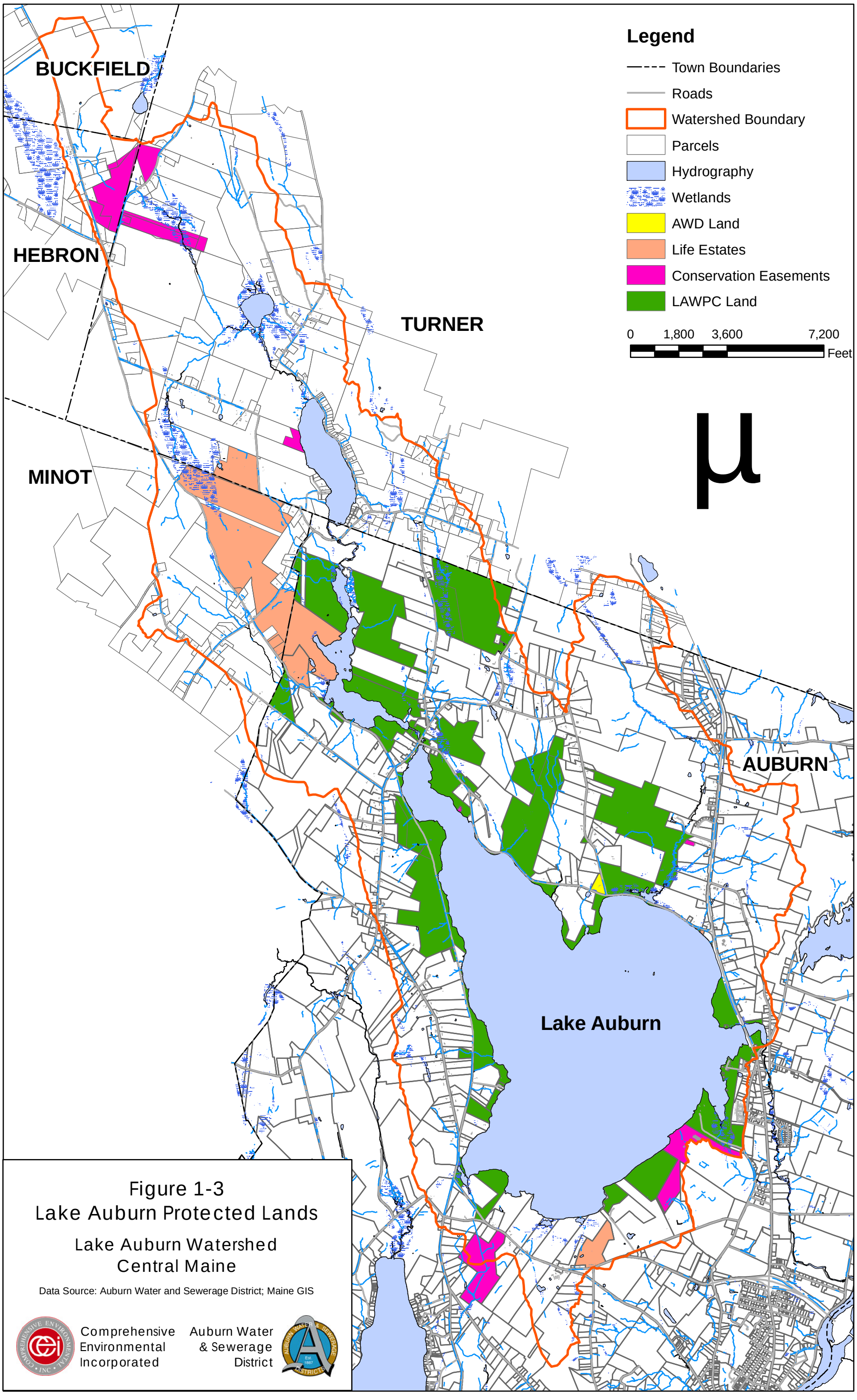


Figure 1-3
Lake Auburn Protected Lands

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

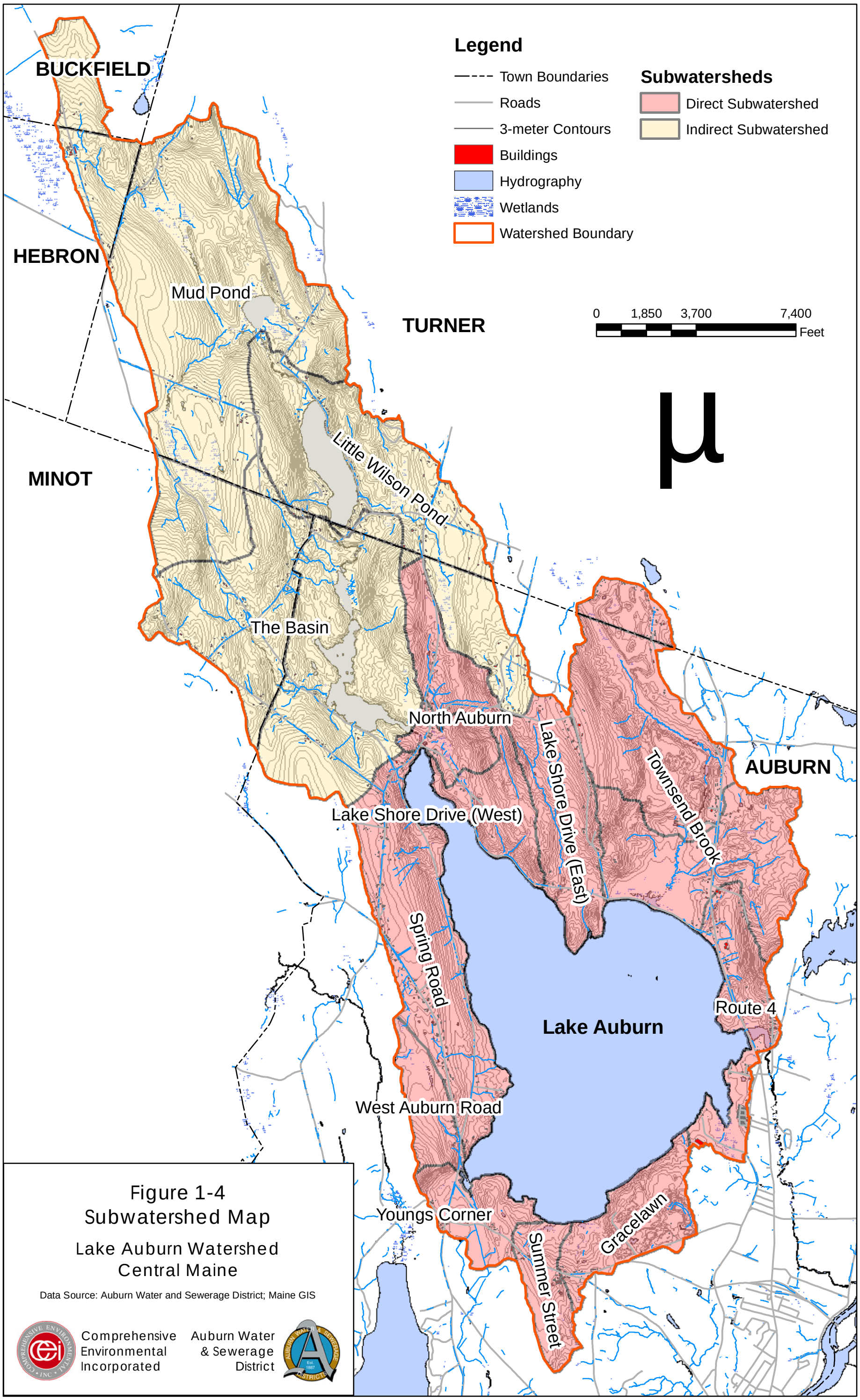


Figure 1-4
Subwatershed Map

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

2.0 Pollutant Source Analysis

Determining a best course of action for maintaining existing water quality requires an understanding of pollutant loadings and how the water quality in Lake Auburn responds to them. The pollutant most commonly used as an indicator of lake health and for planning lake management activities is phosphorus since excess levels can create increased algal blooms, which can contribute to other water quality problems such as increased turbidity, taste and odor problems, which may require expensive treatment. Data on phosphorus loadings associated with stormwater runoff and other pollution sources and how lakes respond to these loadings is also readily available. As such, phosphorus was selected as the overall indicator of lake health for Lake Auburn.

To assist with the estimation of phosphorus loadings from the watershed, CEI selected the Generalized Watershed Loading Function – Enhanced (GWLF-E) Version 7.2.3 model with ArcView Generalized Watershed Loading Functions (AVGWLF) Version 7.1 geographical information systems (GIS) interface to assist with the development of phosphorus estimates. In combination with this software, CEI used the Reckhow Phosphorus Lake Model to predict in-lake phosphorus concentrations based on the projected loadings and to calibrate these loadings to match observed in-lake concentrations.

Although used to represent overall Lake health and for Lake management purposes, phosphorus is not the only indicator of Lake health. Fecal coliform is an extremely important indicator of water quality and is used to demonstrate that the raw water meets the filtration avoidance criteria of the Surface Water Treatment Rule. Excess levels of fecal coliform above the criteria could require the use of filtration to treat the raw water. In fact, elevated fecal coliform levels in 2004 nearly resulted in an EPA order to install filtration as a form of treatment. Fortunately, Auburn Water District and Lewiston Water Division were able to trace the coliform to a gull and waterfowl population and institute a program to mitigate the heavy gull influx on Lake Auburn. Turbidity is also an indicator of water quality and is often used to help determine disinfection requirements. So although phosphorus is used to quantitatively manage watershed controls, these other indicators are still an important consideration and recommendations are included to address coliform and sediment contributions to the Lake.

2.1 Input Data and Assumptions

Inputs to the combined model include land use and lake data. CEI focused on the outputs of estimated pollutant loadings and the corresponding impact on in-lake pollutant concentrations. To be consistent with references used in this analysis and to maintain consistency between Lake concentrations that are provided in metric units and pollutant loadings, the metric system is used to present calculations pertaining to phosphorus loadings (e.g., kg) and in-lake concentrations (e.g., µg/l). Once the correlation between loadings and Lake concentrations under existing conditions has been established, the phosphorus loadings to the Lake are presented in English units (e.g., pounds), as this is a more common unit of measure in the United States. The data used in the model along with a description of its purpose is described below.

Subwatersheds

The Lake Auburn watershed was divided into thirteen major subwatersheds (Figure 1-4), which are further divided into two categories: 1) direct subwatersheds to Lake Auburn, and 2) indirect subwatersheds. Direct subwatersheds drain stormwater runoff directly into Lake Auburn and its tributaries and include: North Auburn; Lake Shore Drive (West); Lake Shore Drive (East); Spring Road; Townsend Brook; West Auburn Road; Route Four; Youngs Corner; Summer Street; and Gracelawn. Indirect subwatersheds include land areas that drain to another pond or lake before entering Lake Auburn, providing some level of treatment before reaching Lake Auburn. Indirect subwatersheds include: Mud Pond; Little Wilson Pond; and The Basin. Each subwatershed represents the drainage area to a tributary or area of direct discharge to the Lake. This provides localized information to allow for prioritization of future remedial actions through identifying areas with the greatest pollutant loadings.

The subwatershed boundaries are natural boundaries dictated by the local topography. These boundaries generally follow ridgelines or high points and represent the area that drains to the farthest downgradient point, which is typically the location where a stream enters the lake. Further subdivision was performed where best management practices (BMPs) were proposed to evaluate specific pollutant loadings to and removals associated with the BMP. Table 2-1 shows the land area for each subwatershed, excluding major ponds and lakes.

Table 2-1. Land Area by Subwatershed

Subwatershed	Land Area (acres)
Gracelawn	334
Lake Shore Drive (East)	450
Lake Shore Drive (West)	240
Little Wilson Pond	838
Mud Pond	2214
North Auburn	537
Route 4	346
Spring Road	803
Summer Street	189
The Basin	1587
Townsend Brook	1470
West Auburn Road	176
Youngs Corner	229
Total	**9413**

Land Use and Land Cover

Land use and land cover within the watershed relate directly to the amount of runoff and pollutant loadings to the lake. Generally, more intensely developed land uses with larger impervious area will produce more runoff and pollutant loadings than undeveloped forested areas. Land use data in the watershed was used to estimate stormwater runoff and pollutant loads from the watershed under existing and buildout conditions.

Existing land use data within the Lake Auburn watershed was obtained from datasets provided by the New England Interstate Water Pollution Control Commission, and developed by Penn State Institutes of the Environment specifically for AVGWLF application[1]. Some modifications were made to the mapped land use data to reflect actual land uses within the watershed based on a comparison with orthophoto imagery. Specifically, the available spatial land use data showed several low-intensity developed areas as forested. Study of the orthophoto imagery reflected an average disturbance area of approximately 1.25 acres per lot in the Lake Auburn watershed, including the house, driveway and lawn area in each lot. Using a count of houses on land designated as "forested," modifications were made to the GWLF-E model land use inputs to include the corresponding disturbed areas designated as "low intensity development". Additionally, a 32-acre quarry area in the Upper Townsend Brook subwatershed and a 21-acre agricultural area in the Gracelawn subwatershed were mapped as forested. The quarry was converted to low-intensity urban development and the agricultural area was converted to cropland.

Table 2-2 shows the type and quantity of each land use by subwatershed as mapped and adjusted for use in the model to reflect actual conditions. Table 2-3 shows the percentage of land area in each subwatershed. Table 2-4 shows the type and quantity of each land use by Town. Table 2-5 shows the percentage of land area by Town. Figure 2-1 shows the existing land uses throughout the watershed (this does not reflect the adjustments discussed above).

[1] Penn State Institutes of the Environment. February 2007. Summary of Work Undertaken Related to Adaptation of AVGWLF for Use in New England and New York.

Table 2-2. Land Use Area by Subwatershed							
	Land Use Area (acres)						
Subwatershed	**Hay/ Pasture**	**Cropland**	**Forested**	**Wetland**	**Low-Intensity**	**High Intensity**	**Total**
Gracelawn	2	23	249	0	56	4	334
Lake shore Drive, East	70	14	348	5	4	9	450
Lake Shore Drive, West	2	0	224	1	3	10	240
Little Wilson Pond	11	11	737	12	27	39	838
Mud Pond	231	47	1708	148	23	56	2214
North Auburn	57	0	434	14	11	20	537
Route 4	42	6	200	16	38	44	346
Spring Road	141	12	580	5	19	46	803
Summer Street	21	38	122	4	0	4	189
The Basin	100	22	1361	25	27	52	1587
Townsend Brook	180	0	1096	54	82	58	1470
West Auburn Road	8	0	159	8	1	1	176
Youngs Corner	94	0	119	3	1	12	229
Total	**960**	**173**	**7337**	**296**	**292**	**356**	**9413**

Table 2-3. Land Use by Percent Subwatershed Area

	Land Use Area (Percent Subwatershed Area)						
Subwatershed	**Hay/ Pasture**	**Cropland**	**Forested**	**Wetland**	**Low-Intensity**	**High Intensity**	**Total**
Gracelawn	1%	7%	74%	0%	17%	1%	4%
Lake shore Drive, East	16%	3%	77%	1%	1%	2%	5%
Lake Shore Drive, West	1%	0%	93%	0%	1%	4%	3%
Little Wilson Pond	1%	1%	88%	1%	3%	5%	9%
Mud Pond	10%	2%	77%	7%	1%	3%	24%
North Auburn	11%	0%	81%	3%	2%	4%	6%
Route 4	12%	2%	58%	5%	11%	13%	4%
Spring Road	18%	1%	72%	1%	2%	6%	9%
Summer Street	11%	20%	65%	2%	0%	2%	2%
The Basin	6%	1%	86%	2%	2%	3%	17%
Townsend Brook	12%	0%	75%	4%	6%	4%	16%
West Auburn Road	5%	0%	90%	4%	1%	0%	2%
Youngs Corner	41%	0%	52%	1%	1%	5%	2%
Total	**10%**	**2%**	**78%**	**3%**	**3%**	**4%**	**100%**

Table 2-4. Land Use by Town

	Land Use Area (acres)						
Town	**Hay/ Pasture**	**Cropland**	**Forested**	**Wetland**	**Low-Intensity**	**High Intensity**	**Total**
Auburn	675	100	4315	139	229	233	5691
Buckfield	55	0	96	0	1	6	158
Hebron	21	0	140	0	8	13	182
Minot	70	21	716	39	8	31	885
Turner	139	52	2070	117	47	73	2497
Total	**960**	**173**	**7337**	**296**	**292**	**356**	**9413**

Table 2-5. Land Use by Percent Town Area							
	Land Use Area (acres)						
Town	**Hay/ Pasture**	**Cropland**	**Forested**	**Wetland**	**Low-Intensity**	**High Intensity**	**Total**
Auburn	12%	2%	76%	2%	4%	4%	**60%**
Buckfield	35%	0%	61%	0%	0%	4%	**2%**
Hebron	11%	0%	77%	0%	4%	7%	**2%**
Minot	8%	2%	81%	4%	1%	4%	**9%**
Turner	6%	2%	83%	5%	2%	3%	**27%**
Total	**10%**	**2%**	**78%**	**3%**	**3%**	**4%**	**100%**

Soils

GWLF-E employs soils data to determine the permeability of soils throughout the watershed. Soil permeability helps in determining runoff coefficients, as well as feasibility of implementing infiltration techniques.

The Natural Resource Conservation Service (NRCS) classifies soils into four Hydrologic Soil Groups (HSG) based on the soil's runoff potential. The four HSGs are A, B, C and D, where A soils generally produce the smallest runoff and allow for the greatest infiltration and D soils generally have the greatest runoff potential. Following is a brief description of the four HSGs:

- HSG A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- HSG B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
- HSG C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
- HSG D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface and shallow soils over nearly impervious material.

Figure 2-2 shows the hydrologic soil groups throughout the watershed.

Precipitation

Precipitation data is necessary to determine groundwater seepage, stormwater runoff and evapotranspiration volumes in the model. GWLF-E processes daily precipitation data to simulate watershed streamflow on a daily basis.

The Auburn Water District provided daily precipitation data used in the GWLF-E model for calendar years 2001 through 2008. The City of Lewiston Department of Public Services, in Maine, maintains the rainfall gage. The New England Interstate Water Pollution Control Commission provides data sets for AVGWLF, including precipitation records. Daily precipitation data from the National Weather Station in Gardiner, Maine, included in these data sets, was used to fill in local precipitation data gaps. Based on the revised data, the average precipitation over the 2001 to 2008 period was approximately 45 inches per year.

Temperature

GWLF-E uses outdoor temperature data to determine whether precipitation occurs as rainfall or snow to then estimate snowmelt and evapotranspiration in the watershed. The Auburn Water District also provided daily maximum, minimum and mean temperatures for the period 2001 through 2008.

Evapotranspiration

Evapotranspiration represents the volume of precipitation that evaporates from the watershed or is taken up by plants and then recycled back into the atmosphere. The losses associated with evapotranspiration are used in the estimation of streamflows into the Lake. The GWLF-E model estimates evapotranspiration based on land use and temperature data. Evapotranspiration in the Lake Auburn watershed was estimated as 31% of the annual precipitation.

Flow Data

In 2004, the United States Geologic Survey published a water budget[2] for Lake Auburn, using measured streamflow at three points in the watershed. The report included estimates of total inflows to and outflows from Lake Auburn. The published surface water inflows to Lake Auburn used a combination of direct measurements and estimation methods. Continuous streamflow gage data was available for The Basin Outlet and Townsend Brook to Lake Auburn, as well as outflows from Lake Auburn at Bobbin Mill Brook, for the period of water-budget years 2001 through 2003. The Townsend Brook streamflow measurements were used to calibrate flows generated by the GWLF-E model as described later in this section.

[2] Dudley, Robert. Water Budget for Lake Auburn, Maine, May 1, 2000 through April 30, 2003, Scientific Investigations Report 2004-5106.

Septic Systems

While septic systems throughout the watershed, including those at greater distances from the Lake, can contribute pollutants such as nitrates, phosphorus contributions from septic systems are more likely to occur from systems located within 300 feet of the Lake.[3] Counts of septic systems within 50 feet and between 50 feet and 300 feet of the lake, upstream ponds and major tributaries were determined under the assumption that the number of dwellings within the buffer represented the number of septic systems. Estimates of loadings associated with septic systems are made using these pieces of information.

Land Use Phosphorus Loadings

GWLF-E models pollutant loadings as a function of land use and pollutant load values, as compiled by Haith et al.[4]. The model provides default pollutant loading values as stormwater concentrations for rural land uses, such as agricultural and forested areas. The model uses a pollutant buildup and washoff function for urban areas. The buildup and washoff function is used for urban areas due to the greater impervious surfaces and behavior of pollutants on these surfaces. Pollutants will accumulate exponentially between storms in these areas and the buildup and washoff function accounts for this buildup over time (e.g., high intensity development accumulates 0.00445 kilograms of phosphorus per acre of land per day, which is adjusted exponentially for long dry periods) to estimate the anticipated loading from each storm event. This helps account for the differences in concentrations measured in stormwater (e.g., based on the timing from the last storm). The more pervious areas show more consistent stormwater runoff concentrations, therefore a straightforward concentration in stormwater runoff (e.g., assumes forested lands always produce a concentration of 0.006 mg/L in stormwater runoff for every storm) is used by the model. Table 2-6 shows the initial pollutant loads by land use used in the model for total phosphorus.

Table 2-6. Initial Phosphorus Loading Coefficients by Land Use

Source	Phosphorus Loading Coefficient	Units
Hay/Pasture	0.206	mg/L
Cropland	0.206	mg/L
Forest	0.006	mg/L
Wetland	0.006	mg/L
High Intensity Development	0.00445	kg/acre/d
Low Intensity Development	0.00081	kg/acre/d

[3] Special issue: fate of phosphorus in septic tanks (autonomous waste water treatment systems). *Scope Newsletter*. Number 63. January 2006.
[4] Haith, Douglas A., Ross Mandel and Ray Shyan Wu. Generalized Watershed Loading Functions, Version 2.0, User's Manual. December 15, 1992.

Bathymetric Data

The Auburn Water District provided bathymetry information for Lake Auburn, included as Figure 2-3. The bathymetry was used to estimate water volumes associated with the stratified layers of the Lake. Stratification occurs when temperature variations are experienced at different depths in the Lake, with warmer waters near the surface and cooler waters at the bottom (warm water is less dense than cool water and generally floats, while cold water sinks). When the Lake thermally stratifies, it separates into three layers: epilimnion, (top-most layer), the metalimnion or thermocline (middle layer denoted by a rapid decrease in temperature with depth), and the hypolimnion (dense, bottom-most layer). Seasonal stratification is common as weather patterns change and ice forms and melts on lakes. These volumes contributed towards calculations of average in-lake phosphorus concentrations and estimates of internal phosphorus recycling. The bathymetry also showed the deepest area of the Lake, used for sampling.

2.2 Water Quality

The Auburn Water District (AWD) and Lewiston Water Division (LWD) maintain an extensive database of water quality data collected from Lake Auburn and the watershed, dating as far back as 1979 with temperature and dissolved oxygen profiles in the deep spot of the lake. AWD and LWD performed most of the data collection. The data focuses on raw water quality at the intake for compliance purposes and raw water quality at the deep hole of the lake to evaluate water quality trends and the overall health of the Lake. The two agencies also performed some lake shore sampling, primarily at locations where tributaries enter the Lake. The AWD/LWD maintains a large database of the information collected. A map of the sampling locations is shown in Figure 2-4 and Figure 2-5.

In-Lake Sampling

For the purposes of this study, the water quality collected from the deep spot of the lake (sample ID DEEP HOLE) was the primary focus to assess water quality under stratified lake conditions (Figure 2-4). This data was the most useful for determining the trophic status, or health, of the lake and for calibrating phosphorus loadings calculated in the model as it allowed for a direct comparison of modeled phosphorus concentrations to observed phosphorus concentrations.

Dissolved oxygen and temperature data from profile samples at the deep spot of the Lake were collected between 1979 and the present. These profile data revealed the stratification characteristics of the Lake, which were used to determine differences in water quality amongst these layers. Studies showing the relationship between dissolved oxygen and temperature helped define where the lake stratifies at different times of the year, as indicated by significant changes in temperature and dissolved oxygen gradients. Appendix A contains the graphs created for these efforts.

Generally, the stratification patterns are seasonal; stratification begins in the spring and becomes more defined through fall, with little to no stratification in the winter. When the Lake thermally stratifies, it separates into three layers: the epilimnion, or top-most layer; the metalimnion or thermocline, the middle layer denoted by a rapid decrease in temperature with depth; and the hypolimnion, the dense, bottom-most layer. Table 2-7 summarizes the average depths of these three layers during each season. Note that actual depths in a given year vary depending on the weather.

Table 2-7. Stratification by Season

		Depth of Stratified Layers (feet)		
Season	**Months in Season**	**Epilimnion**	**Metalimnion**	**Hypolimnion**
Spring	May	0-20	20-30	30-bottom
Summer	June – August	0-23	23-36	36-bottom
Winter	November – April	No Stratification	No Stratification	No Stratification
Fall	September – October	0-43	43-49	49-bottom

The lake stratification provides significant information for determining how phosphorus concentrations behave within the Lake, namely, quantifying the potential for pollutant contributions from lake-bottom sediments. Table 2-8 provides a summary of the available phosphorus data from water column samples at the deep spot of the Lake, categorized by epilimnion, metalimnion and hypolimnion.

As expected, under stratified conditions the hypolimnion typically has a much higher phosphorus concentration than the epilimnion. Low oxygen levels allow for the release of phosphorus from bottom sediments back into the water column. Stratification of the Lake keeps these higher concentrations at the bottom of the lake until mixing, or turnover occurs; therefore, the sediments released from the bottom of the Lake only mix with the full lake volume during spring and fall turnover when temperatures are more consistent throughout the water column. Although limited, phosphorus data from 2005 shows an increase in in-lake phosphorus concentrations in the epilimnion layer in the fall and winter, with the lowest concentrations in the summer (Figure 2-6). This indicates an increase in concentrations after fall turnover, however, there is not enough phosphorus sampling data throughout the water column profile to determine whether this is the result of high concentrations in the hypolimnion from sediment release or the result of a suspended layer of phosphorus-laden decaying plants above the thermocline. Even with this mixing, the average annual concentration in the epilimnion layer remains relatively low at 9.8 µg/l, with average spring levels at 10.3 µg/l.

Table 2-8 Observed In-Lake Phosphorus Concentrations (µg/l)

Date	Epilimnion	Metalimnion	Hypolimnion	CORE 0-9m	Full CORE
11/17/1986	10	8	18		
2/19/1987	1	9	124		
4/24/1987	11	70	18		
1/30/1990	<10	10	21		
10/25/1990			42		
12/6/1990			10		
2/20/1991	20	<10	10		
5/29/1991	<10	<10	10		
9/24/1991	<10	<10	34		
11/7/1991	12	10	12		
2/18/1992	<10	<10	<10		
10/21/1999	62				
10/21/1999			37		
10/21/1999			12		
10/4/2000			57		
10/23/2001					10
10/23/2001			38		
6/26/2002					12
6/26/2002			21		
9/26/2002					9
5/30/2003			11		
5/30/2003			14		
6/26/2003					10
6/26/2003			12		
7/31/2003				7	
7/31/2003			17		
9/3/2003			20		
6/3/2004			13		
6/3/2004					10
7/1/2004					8
7/1/2004			18		
4/25/2005	10				
8/1/2005	7				
8/22/2005	7				
4/25/2005	10				
5/23/2005	10				
6/20/2005	7				
8/1/2005	7				
8/22/2005	7				
9/19/2005	9				
10/3/2005	9				
10/18/2005	11				
11/7/2005	11				
11/21/2005	13				
12/5/2005	14				
8/29/2006				9	
9/25/2006				9	
6/21/2007				6	
6/25/2008					9
7/23/2008					6
9/24/2008					10
Average In-Lake Concentrations by Season					
Spring	10.3	10.0	13.3		
Summer	7.0		16.2	7.3	9.2
Winter	11.1	9.8	12.6		
Fall	9.8	9.0	32.3	9.0	9.7
Average Annual In-Lake Concentration	**9.8**	**9.6**	**16.8**		

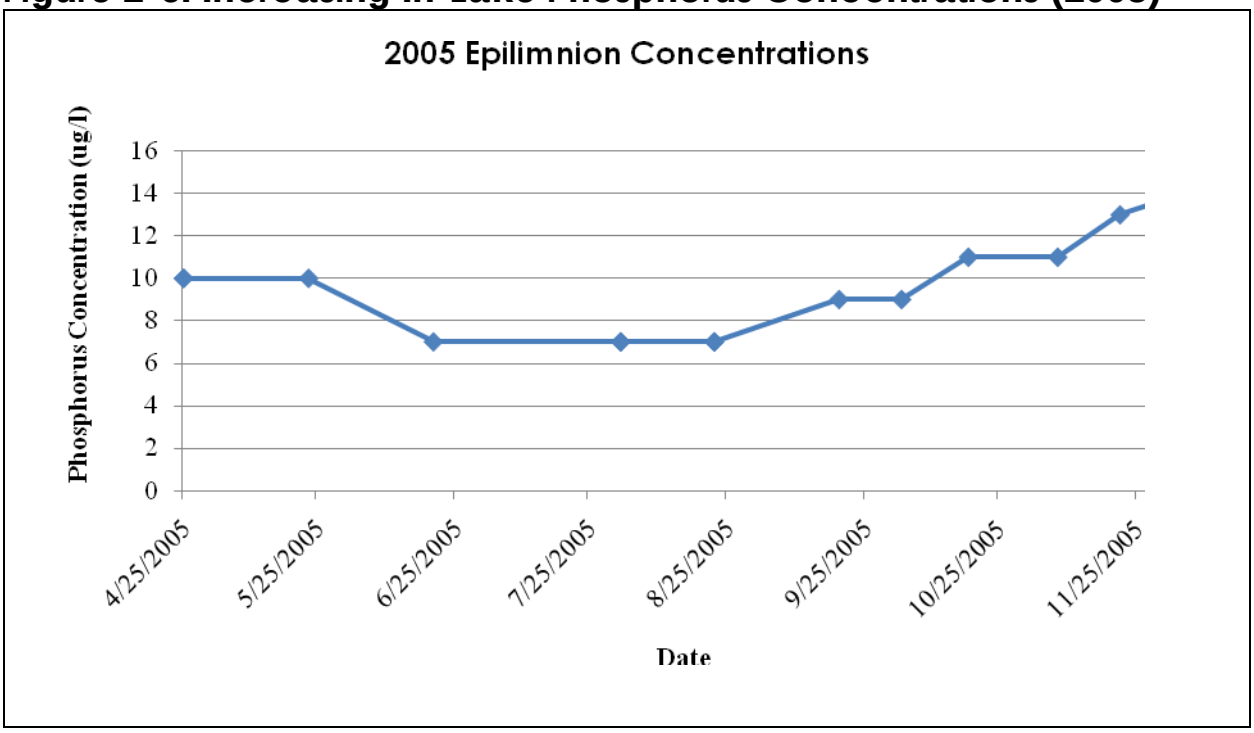
Notes:

(1) Average seasonal concentrations represent the average of all data for a particular season (months included in each season are included in Table 2-7) exclusive of the hypolimnion concentration of 124 on 2/19/87, the metalimnion concentration of 70 on 4/24/87 and the epilimnion concentration of 62 on 10/21/99, which are anomalous data sets that skew the average.

(2) Average Annual In-Lake Concentrations by stratified layer represent a weighted average based on the number of months in each season as follows:

Average Annual In-Lake Concentration = (Spring Conc.*1 month + Summer Conc.*3 months + Winter Conc.*6 months + Fall Conc.*2 months)/12 months

Figure 2-6. Increasing In-Lake Phosphorus Concentrations (2005)



In comparison to other lakes, it is difficult to find a lake and watershed that is exactly equivalent to Lake Auburn in terms of depth, area, volume, watershed land uses, etc. Compared to other public water supply watersheds in Maine, Lake Auburn has less forest cover, and more developed/disturbed land (over 10%), and is under continuing development pressure. Given that water quality impacts start to appear at 7 to 10% developed, the current level of development and disturbance is a management challenge and requires attention. The water quality data reviewed for the Source Water Assessments indicated that the Lake is at risk from development and other activities that increase nutrient inputs.[5] Thus, it is important to maintain a strong water supply protection program to maintain the water quality of the lake.

In addition to phosphorus sampling, the AWD and LWD sample numerous other parameters to assess the water quality of the Lake and to show compliance with the conditions of the filtration waiver. Among these parameters are pathogens, sampled as fecal coliform. High fecal coliform levels above water quality conditions permitted by the filtration avoidance criteria were discovered in the raw water in 2004, nearly resulting in an EPA order to install filtration to treat the raw water. AWD and LWD quickly traced the source to an influx of gulls and other waterfowl and instituted an annual gull control program that has successfully kept the lake within permitted source water quality conditions and allowed AWD and LWD to keep their filtration waiver. Records of these and other sampling parameters are kept by the AWD and LWD. This incident demonstrates the significance and importance of other pollutants in monitoring the health of the lake. As such, these other key pollutants including pathogens and turbidity are also addressed in this plan.

[5] Tolman, Andrews L., Maine CDC Drinking Water Program, (personal email communication, March 24, 2010)

The highest epilimnion phosphorus concentrations occur during the winter, when algal and plant growth does not occur. Because of this and the depth of the Lake, the average spring concentration of 10.3 µg/l in the epilimnion layer, instead of the highest evident concentration, was used to assess phosphorus loadings to the Lake with the lake response model.

Tributary/Inlet Sampling
Tributaries to the Lake have historically been sampled for phosphorus and other parameters. A map of tributary sampling locations is shown on Figure 2-5. A summary of the phosphorus results is included in Table 2-9.

The results show the greatest phosphorus concentrations along the northeast side of the lake from First Brook and Townsend Brook, which contains some developed areas along the brook. These areas also showed higher pathogen concentrations (Fecal Coliform and Enterococci) than other locations on many occasions. Townsend Brook is also one of the larger tributaries to the Lake, with greater flows carrying greater overall pollutant loads.

However, flow data was not collected at the time of sampling, therefore the data cannot be used to determine loads associated with streamflows.

2.3 Flow Calibration

GWLF-E estimates surface runoff and infiltration to model the resulting hydrology within the watershed. Precipitation falls on the ground surface and either evapotranspires, infiltrates into the soil or runs over the ground depending on several variables (e.g., land use, soil type, temperature). The infiltrate that does not evapotranspire, evaporating directly or through plant transpiration, either moves through soil to surface waters as baseflow or seeps downward into a deep aquifer.

AVGWLF, the GIS interface, calculates the necessary model parameters based on the spatial data inputs. The GWLF-E model then generates daily flow data based on precipitation, land use, soil conditions and other environmental characteristics. GWLF-E provides some flexibility to adjust calculated parameters, allowing for adjustments to calculated flow information.

As previously discussed, the USGS prepared a water budget for Lake Auburn in 2004, representing flows between 2000 and 2003. As part of this budget, gages were used to measure continuous streamflows during this period at two inlets to Lake Auburn, including The Basin Outlet and Townsend Brook to Lake Auburn, and the outlet from Lake Auburn, Lake Auburn at Bobbin Mill Brook.

Table 2-9. Tributary Phosphorus Concentrations (ug/l)

	Outlet of Lake, Site #1	Townsend Brook, Site #2	Brook Near Tabor's, Site #3	Culvert on Lake Shore Dr., Site #4	North Auburn Bridge, Site #13	Basin - Before Dam, Site #16	Outlet to Little Wilson Pond, Site #17	Inlet to Little Wilson Pond, Site #18	Horse Pond on Lake Shore Dr., Site #23	First Brook on Lake Shore Dr., Site #25	Tot Lot, Site #26	Johnson Road, Site #27	Milfoil Bouy Line (Lake)
10/21/1999		2			9								
5/31/2000	11	22	6	5	16	19	10	13	9	26	22		
4/12/2000	10	16	5	8	11	13	15	10	7	25	14		
6/28/2000	17	30	10	9	24	10	12	18		28	22		
8/9/2000	16	21	11	11	18	12	11	16			20		
8/30/2000	10	16	12		16	11	12	14			15		
10/4/2000		26	21			12	16	16			24		
4/3/2001	7	21	5	5	8		8				20	8	
4/25/2001	10	18	7	9	10	10	21	13	10	23	100	10	
5/17/2001	16												
5/17/2001	11												
5/23/2001	24	27	7	7	19	11	11	18	17	31	17	8	
6/28/2001	16	28	16	8	26	16	25	28			27	9	
7/31/2001	11	18	14		18	23	20	19			20		
9/12/2001	12	21	15		13	18	22	22			18		
10/23/2001	15	15	18		13	12	26	18			16		13
3/20/2002	19	11	9	4	11	8	11	9	9	26	10	4	
4/24/2002	14	14	4	5	12	20	11	13	9	13	14	6	
5/30/2002	18	21	5	7	54	10	11	13	36	18	26	6	
6/27/2002	23	30	8	7	20	12	13	21	25	21	29	8	
7/31/2002	13	15	10		17	12	23	21			24		
8/29/2002	14	12	12		30	54	40	30			21		
9/25/2002	13	17	13		18	11	20	14			24		
10/23/2002	16	12	7		12	9	14	14			18		
4/24/2003	26	16	6	8	8	9	11	10	15	31	16	7	
6/25/2003	16	26	10	9	16	10	12	24	24	25	25	10	
7/30/2003	16	21	14		34	9	25	20			22		
8/28/2003	12	14	14		14	11	11	18			14		
5/26/2004	11	22	7	11	15	12	11	15	14	26	26	16	
6/30/2004	15	28	19	8	20	21	12	18		33	23	7	
8/25/2004	13	19	9	12	14	10		15		23	29	7	
4/13/2005	9	15	5	6	8	8	11	10	8	20	15	6	
5/16/2005	<1	16	5	7	10	9	10	10		25	4	6	
6/13/2005	1	22	7	13	1	36	14	17		34	6	8	
7/11/2005	19	28	10	15	14	10	12	19		3	8	11	
8/9/2005	1	20	11		24	<1	23	17			5		
9/12/2005	36	18	18		15	35	12	16			23		
10/4/2005	16	22	12		13	12	13	9			19		
11/7/2007						8							
4/3/2008						3							
4/16/2008						6							
Averages	14.49	19.44	10.34	8.29	16.60	14.22	15.56	16.41	15.25	23.94	21.03	8.06	13.00

The GWLF-E model generated daily inflow to the Lake based on input created with AVGWLF, as discussed above. GWLF-E estimated flows for the model period 2001 through 2008. To calibrate the model, Townsend Brook gaging data (USGS Gage Number 01056480) was compared to model generated flows in Townsend Brook for the period of record. This helped to determine the extent of correlation between the modeled and observed flows, and to then make adjustments as needed to better fit modeled flows with observed flows. Because storage impoundments upstream of other available gages buffer the streams' reactions to precipitation events, the model calibration considered only the Townsend Brook gage. For example, matching records collected at The Basin Outlet gage would be difficult because flows are controlled by factors not predicted in the model (i.e., the outlet structure and water levels within The Basin).

The key flow calibration parameters within the model include curve numbers, a recession coefficient and a seepage coefficient. These parameters have the greatest influence on the shapes of modeled hydrographs, which indicate the streamflow peaks due to stormwater runoff and the baseflow between storm events.

The AVGWLF interface determines curve numbers for watershed areas based on soil type and land use data. However, comparison to TR-55[6] revealed that the model predicted high curve numbers, resulting in greater runoff. Table 2-2c in the TR-55 Manual was used to adjust the curve numbers downwards, providing a better fit to observed flows.

AVGWLF also calculates a groundwater recession coefficient, which represents the "lag time" for subsurface flow to reach streams. Higher recession coefficients correspond to high flows appearing more quickly in the streamflow whereas lower values correspond to greater subsurface storage and slower release of baseflows to streamflow.

The seepage coefficient represents the fraction of infiltrated groundwater that is lost to an underlying aquifer or deep saturated zone. Allowing for seepage shifts the entire hydrograph curve towards zero, reducing overall model-predicted inflows.

The main intent of the GWLF-E model is not accurate prediction of watershed hydrology, rather, the model focuses primarily on the prediction of annual average pollutant loads from the watershed based on stormwater runoff. The model is limited to using average daily precipitation values to predict average daily, monthly and annual flows, while the gaged streamflow data represents stream responses to actual hourly rain events. Therefore, it is difficult to accurately match the model predicted curve with the gaged data. Within these limitations, the model tended to over-predict flows for some periods and under-predict for others. A close fit of the hydrograph curve for the entire period proved unrealistic based on the limited changes allowed within the model. As a result, calibration focused on obtaining the best fit such that total average annual flow volumes estimated by the model matched as well as possible with those observed by the USGS gage. The results reveal that average annual precipitation for the modeled period was 19% higher than the average annual precipitation for the three year USGS study, thus, one would expect the modeled streamflows to be roughly 19% higher than USGS gaged data. Modeled

[6] US Department of Agriculture, Natural Resources Conservation Service. Urban Hydrology for Small Watersheds: Technical Release 55. June 1986.

average annual inflows were 18% higher than USGS measured average annual flows, which correlates to a 1% difference when accounting for differences in precipitation. This provides a reasonable estimation to determine pollutant loads from the watershed under various land use scenarios. Appendix B contains the final calibration curve and estimated flow volumes for the period of calibration.

Model results including direct precipitation, baseflow and runoff (streamflow) contributed to an estimate of average annual water budget for Lake Auburn. These components together make up the inflow to the Lake and evaporation, while withdrawals and outlet flows make up the outflows. Table 2-10 lists these volumes, as discussed below.

Table 2-10. Water Budget		
Precipitation (inches)		44.81
Inflows (million ft^3)		
Direct Precipitation		367
Streamflow		594
Baseflow	*486*	
Runoff	*108*	
Total		961
Outflows (million ft^3)		
Outlet		413
Evaporation		190
Withdrawals		358
Total		961

Inflows

Direct precipitation – Direct precipitation comprises average annual precipitation of 44.81 inches multiplied by the lake surface area of 2,259 acres. Direct precipitation contributes approximately 367 million cubic feet to the lake inflow.

Baseflow – Baseflow represents the volume of water that enters the lake or its tributaries as groundwater flow. GWLF-E calculated baseflow volume as 486 million cubic feet.

Runoff – Runoff represents the volume of water that enters the lake or its tributaries as stormwater flow over land in the watershed. GWLF-E calculated runoff volume as 108 million cubic feet.

Outflows

Evaporation – CDM estimated average annual evaporation from the Lake Auburn watershed in the 1987 study as 23.5 inches per year. USGS also estimated average annual evaporation in the 2004 water budget study as 22.8 inches per year. Because evaporation is a function of temperature data, it is not anticipated to change significantly from the previous studies. An average evaporation rate of 23.15 inches per year was applied to the surface area of the lake, resulting in an average evaporation loss of 190 million cubic feet.

Withdrawals – The Auburn Water District provided withdrawal information for the eight-year period 1994 through 2008. The average annual withdrawal from Lake Auburn for water supply over the 2001 through 2008 period was 358 million cubic feet.

Outlet flows – Outlet flows represent the water leaving the Lake through the Bobbin Mill Brook outlet. Because there is no longer a gage at this outlet, flows are assumed as the difference between inflows and evaporation and withdrawals, or 413 million cubic feet. This compares reasonably well with estimates from the 1987 CDM Plan of 471 million cubic feet, but is considerably higher than the USGS measured average outlet flows.

Lake Residence Time

Lake residence time, also known as flushing rate) is the amount of time that water spends in a lake. It is calculated by dividing the lake volume by the flow in or out of the lake. For Lake Auburn, the residence time was calculated as follows:

Residence Time = Lake Volume/Inflow

Where:

Lake Volume = 3,920 million ft^3
Inflow = 961 million ft^3/yr

Residence Time = 3,920/961 = 4.08 years

2.4 Pre-Calibration Phosphorus Load Estimates

Phosphorus loads from various sources within the watershed were modeled, including direct precipitation, stormwater runoff, baseflow, septic systems, streambank erosion and internal recycling, as described below.

Direct Precipitation

Phosphorus loadings from direct precipitation into the Lake were estimated by multiplying the lake area by a loading coefficient of 0.081 kg/acre-yr[7]. This results in an annual phosphorus load of 182.8 kg (403 pounds) per year.

Stormwater Runoff

Phosphorus loadings from stormwater runoff were predicted using the GWLF-E model. Initial default land use loading coefficients were used to predict a load from stormwater runoff of 374.7 kg (826 pounds) per year.

Baseflow

Phosphorus loadings from baseflow were predicted using the GWLF-E model. Baseflow was predicted to contribute 228.2 kg (503 pounds) of phosphorus per year.

Septic Systems

GWLF-E also estimates phosphorus loadings from septic systems based on the model developed by Mandel. The model divides septic system loads into four types: normal, short-circuited, ponded, and direct discharge systems. These are defined as follows in the GWLF User Manual:

> *"Normal System. A normal septic system is a system whose construction and operation conforms to recommended procedures such as those suggested by the EPA design manual for on-site wastewater disposal systems (U.S. Environmental Protection Agency, 1980). Effluents from such systems infiltrate into the soil and enter the shallow saturated zone. Effluent nitrogen is converted to nitrate, and except for removal by plant uptake, the nitrogen is transported to the stream by groundwater discharge. Conversely, phosphates in the effluent are adsorbed and retained by the soil and hence normal systems provide no phosphorus loads to streamflow.*
>
> *Short-Circuited Systems. These systems are located close enough to surface waters (~ 15 m) so that negligible adsorption of phosphorus takes place. The only nutrient removal mechanism is plant uptake…*
>
> *Ponded Systems. These systems exhibit hydraulic failure of the tank's absorption field and resulting surfacing of the effluent. Unless the surfaced effluent freezes, ponding systems deliver their nutrient loads to surface waters in the same month that they are generated through overland flow. If the temperature is below freezing, the surfacing effluent is assumed to freeze in a thin layer at the ground surface. The accumulated frozen effluent melts when the snowpack disappears and the temperature is above freezing.*
>
> *Direct Discharge Systems. These illegal systems discharge septic tank effluent directly into surface waters."*

[7] Reckhow, Kenneth H. and Chapra, Steven C. 1983. Engineering Approaches for Lake Management. Volume 1: Data Analysis and Empirical Modeling. Butterworth Publishers. Boston.

GWLF-E estimates septic system phosphorus loadings using the following equation:

SL = 0.001*a*d*(e-um)

where:

SL = phosphorus septic load
a = the number of people
d = the number of days in the month
e = the per capita tank effluent, a default of 2.5 grams/day of phosphorus
u = the per capita growing season phosphorus uptake, a default of 0.4 grams/day
0.001 = conversion factor for grams to kilograms

Other methods for estimating phosphorus loadings from septic systems assume that all septic systems within a specific buffer (e.g., 65 to 656 feet) to the lake and/or tributaries contribute some phosphorus load. These methods apply a soil retention coefficient, representing the fraction of phosphorus retained by the soils.

Septic contributions for the Lake Auburn Watershed were calculated using a combination of methods. Orthophoto imagery and spatial parcels and building data were used to estimate the number of dwellings within 300 feet of the lake, upstream ponds and major tributaries. Each dwelling within this buffer was assumed to represent a septic system. GWLF-E was used to calculate phosphorus loadings from septic systems within 50 feet of each waterbody and tributary under the assumption that these systems were short-circuiting with no removal of phosphorus. Phosphorus loadings from septic systems located between 50 feet and 300 feet were calculated by multiplying the number of homes by persons per dwelling (2.6 persons per dwelling based on 2000 US Census data) and kilograms of phosphorus contributed by each person (0.7 kg per person[8]). A soil retention coefficient of 0.8, as applied in the 1987 Watershed Management Study, was applied to these loads.

Septic systems were estimated to contribute an average of 120.7 kg (266 lbs) per year of phosphorus.

Internal Recycling

During thermal stratification of the Lake, elevated phosphorus concentrations in the hypolimnion layer indicate that internal recycling of phosphorus is likely occurring through sediment mixing. There is the possibility for this to be released to the water column during fall turnover. Internal recycling was calculated using two methods for comparison. The first method considered the average concentration in the hypolimnion layer under stratified conditions in the fall (September-October), just before turnover would occur. This method rests on the assumption that the entire hypolimnion water volume is at this concentration (this may be conservative since the sample is collected close to the bottom, which is likely higher than concentrations at shallower depths

[8] Litke, David W. Review of Phosphorus Control Measures in the United States and Their Effects on Water Quality. U.S. Geological Survey. Water-Resources Investigations Report 99-4007. 1999.

within the hypolimnion layer) and that all phosphorus in the hypolimnion will mix with the remaining lake volume at turnover, as discussed and shown with the water quality data. Both of these assumptions are conservative and more water quality data is needed to accurately estimate internal recycling loads.

Water quality data records in the month of October show an average phosphorus concentration in the hypolimnion layer of 32.3 µg/l. When multiplied by the hypolimnion volume, this translates to 540 kg (1,190 pounds) of phosphorus in this layer. Concentrations of phosphorus during periods without internal recycling were assumed to be representative of those in the epilimnion layer (9.8 µg/l in the fall, representing the same period of high concentrations in the hypolimnion layer). The amount of phosphorus in the hypolimnion volume using the concentration of 9.8 µg/l was calculated as 164 kg (362 pounds). The difference between the two values was assumed to represent the phosphorus loading associated with internal recycling, or 376 kg (829 pounds) of phosphorus.

This was checked against a second method, which used an equation estimate the sediment-water exchange rate under aerobic conditions. The equation, based on the results of an investigation by Kamp-Nielsen[9], is shown below.

$$\Delta P/\Delta t = -1.38 \log P + 1.88$$

Where:

$\Delta P/\Delta t$ is in mg $PO_4/m^2/day$

P is in µg PO_4/l

With this equation, an equilibrium (no exchange) occurs for a water column phosphorus concentration of about 30 µg/l. A net phosphorus release from sediments occurs when concentrations above aerobic sediments is less than 30 µg/l. Kamp-Nielsen found that aerobic release of phosphorus is independent of the sediment composition.

Assuming the entire lake bottom contributes to an internal load, a phosphorus contribution of 627 kg (1,383 pounds) per year was determined based on this second method. It is unlikely that the entire lake bottom releases phosphorus to the water column, thus, the lesser value of 376 kg (829 pounds) of phosphorus was used to represent internal loadings of phosphorus.

Streambank

Streambank erosion and phosphorus loads attached to the resulting sediment particles were estimated with GWLF-E. Streambank erosion was estimated to contribute 4.5 kg (10 pounds) of phosphorus per year.

[9] Reckhow, Kenneth H. and Chapra, Steven C. 1983. Engineering Approaches for Lake Management. Volume 1: Data Analysis and Empirical Modeling. Butterworth Publishers. Boston. p. 141-142.

2.5 Phosphorus Loads Calibration

The pre-calibrated phosphorus loadings and model predicted runoff rates and baseflow for the period between 2001 and 2008 were input to the Reckhow steady-state lake response model to determine the predicted in-lake concentration associated with these loadings. Due to the limited data on the upstream ponds, it was assumed that all loads entered Lake Auburn directly. While some retention is likely occurring from settling in upstream ponds, the "big-picture" application of the lake response model associates total loads to the lake with an actual in-lake concentration. Thus, the overall loading and needed reductions for each scenario are still valid and applicable for evaluating recommendations. The same holds true regarding the choice of lake response model. All models will not generate the same exact loading results, but the correlation between loads and in-lake concentrations allow for an accurate assessment of percent reductions needed to achieve goals and the actions that will result in these reductions.

The results of this modeling effort showed that initial pollutant loads were underestimated by about 11%. As a result, all pollutant load estimates were increased by 10 to 15% to match predicted in-lake phosphorus concentrations with observed in-lake phosphorus concentrations. This involved adjusting the phosphorus loading factors in the model.
The use of the Reckhow steady-state lake response model requires that the simulated water body is representative of the model basis, shown on Table 2-11. This table shows the minimum and maximum data set levels for the model alongside corresponding levels for Lake Auburn. As shown in Table 2-11, this model is appropriate for Lake Auburn.

Table 2-11. Reckhow Model Minimum and Maximum Loading Values

	Reckhow Acceptable Range	Lake Auburn
Phosphorus Concentration – P (µg/l)	4 – 135	9.8
Annual Areal Phosphorus Loading – L (g/m2-yr)	0.07 – 31.4	0.157
Areal Water Loading – qs (m/yr)	0.75 - 187	3.0

The Reckhow steady-state lake model is expressed as:

$$P = L/(11.6 + 1.2q_s)$$

Where:

L = annual areal phosphorus loading (g/m^2-yr), $L = W/A_s$
W = total phosphorus mass loading (includes stormwater, internal recycling, baseflow) (g/yr)
q_s = areal water loading (m/yr), $q_s = Q/A_s$
Q = inflow water volume to lake (m^3/yr), $Q = (A_d \times r) + (A_s \times Pr)$
A_d = watershed area (land surface) (m^2)
A_s = lake surface area (m^2)
r = total annual unit runoff (m/yr)

Pr = mean annual net precipitation (m/yr)

The predicted in-lake phosphorus concentration using the Reckhow steady-state in lake model after calibration is included in Table 2-12.

Table 2-12. Reckhow Steady-state Phosphorus Model Results After Calibration

Parameter	Value
Lake area – A_s (km^2)	9.1
Mean Depth (m)	12.2
Watershed area – A_d (km^2)	48.2
Phosphorus Loads	
Stormwater runoff phosphorus loadings (kg/yr)	425
Streambank erosion phosphorus loadings (kg/yr)	5
Septic system phosphorus loadings (kg/yr)	133
Phosphorus loadings from direct precipitation (kg/yr)	201
Phosphorus loadings from internal recycling (kg/yr)	413
Phosphorus loadings from baseflow (kg/yr)	255
Total phosphorus loadings – W (kg/yr)	1432
Total phosphorus loadings – L (g/m^2-yr)	0.157
Runoff (m/yr)	0.3
Baseflow (m/yr)	1.5
Direct Precipitation (m/yr)	1.1
Areal Water Loading – q_s (m/yr)	3.0
Predicted In-lake Phosphorus (mg/l)	**0.0103**
Predicted In-lake Phosphorus (µg/l)	**10.3**
Average Observed In-lake Phosphorus (µg/l)	**10.3**

2.6 Calibrated Phosphorus Loadings

Based on the calibration performed modeling runs, the phosphorus loadings by subwatershed were estimated. These are presented in Table 2-13. Phosphorus loadings were also determined by town as shown in Table 2-14. Phosphorus loadings by source, including a breakout by land use are included in Table 2-15.

Table 2-13. Phosphorus Load by Subwatershed	
Subwatershed	**Phosphorus Load (lbs/yr)**
Gracelawn	65
Lake shore Drive, East	87
Lake Shore Drive, West	26
Little Wilson Pond	186
Mud Pond	360
North Auburn	103
Route 4	121
Spring Road	218
Summer Street	67
The Basin	242
Townsend Brook	235
West Auburn Road	19
Youngs Corner	73
Total	**1802**

Table 2-14. Phosphorus Load by Town	
Town	**Phosphorus Load (lbs/yr)**
Auburn	1130
Buckfield	43
Hebron	35
Minot	167
Turner	427
Total	**1802**

Table 2-15. Phosphorus Load by Source	
Source	**Phosphorus Load (lbs/yr)**
Land-based Runoff	
Hay/Pasture	*451*
Cropland	*153*
Forest	*28*
Wetland	*6*
High Intensity Development	*274*
Low Intensity Development	*25*
Land-based Runoff Subtotal	937
Other Land-based	
Streambank Erosion (sediment)	*10*
Baseflow	*562*
Septic Systems	*293*
Other Land-based Subtotal	865
Land-based Runoff & Other Land-based Subtotal	1802
Other Sources	
Precipitation	*444*
Internal Recycling	*911*
Other Sources Subtotal	1355
Total	**3157**

2.7 Buildout

A gross buildout was evaluated to determine potential pollutant loadings and in-lake concentrations assuming a worst-case scenario. The buildout evaluation may be used for planning purposes to mitigate phosphorus loadings associated with new development.

Three scenarios were evaluated for buildout as described below.

Scenario 1. Buildout Under Existing Zoning

Under this scenario, all developable land was modeled as developed to its maximum potential based on existing zoning regulations. Figure 2-7 shows the existing zoning map for the watershed. The following assumptions were applied to the analysis:

- No development within 300 feet of the shoreline in sandy soils in accordance with the current Lake Auburn Watershed Overlay District Ordinance, which does not allow septic systems within this buffer;

- No development on properties with less than 36 inches to groundwater as based on soil maps from the Natural Resources Conservation Service (Figure 2-8), in accordance with Lake Auburn Watershed Overlay District Ordinance, which does not allow septic systems on sites with less than 36" of suitable soil;
- No development within 100 feet of shoreland buffers from streams, ponds and wetlands;
- Protected lands would remain forested (Figure 1-3);
- The above undevelopable land areas were subtracted from the total land area within each zoning district to determine developable land area by zoning district. This evaluation did not consider existing lot frontage and setbacks, which requires a more detailed parcel level analysis. This evaluation, rather, represents a worst-case buildout condition considering that land ownership and construction of new roadways can alter a parcel by parcel analysis;
- Existing zoning densities were applied to total land estimates for residentially zoned areas;
- Agricultural Resource Protection (AR) zoning would be developed assuming one residence per 10 acres with the 88% of remaining land developed as crops;
- Phosphorus loads from low and high intensity areas were limited to those allowed by existing State and local ordinances, whichever is more stringent (see Table 2-16); and
- All new development would be served by septic systems.

Table 2-16. State and Local Per Acre Phosphorus Allocation Requirements

Waterbody	Town	State Total P Allocation (lbs/acre/yr)	Existing Local Total P Allocation (lbs/acre/yr)	Recommended Total P Allocation Requirement (lbs/acre/yr)
Lake Auburn	Auburn	0.072	0.047	0.036
	Turner	0.082	0.082	0.082
Little Wilson Pond	Auburn	0.025		0.025
	Minot	0.038		0.038
	Turner	0.031	0.031	0.031
Mud Pond	Minot	0.033		0.033
	Turner	0.033	0.025	0.025
Mud Pond (in Turner)	Buckfield	0.025		0.025
The Basin	Minot	0.043		0.043
	Turner	0.027	0.02	0.02

These land use changes were input into GWLF-E to predict phosphorus loadings to the Lake under this scenario. Total phosphorus contributions to Lake Auburn under this scenario were 5,043 pounds (3,688 pounds land based) of phosphorus per year, which results in an in-lake concentration of 16.2 µg/l. The results of the analysis are summarized in Tables 2-17 by subwatershed, 2-18 by Town and 2-19 by source.

Table 2-17. Buildout Scenario 1 Phosphorus Load by Subwatershed	
Subwatershed	**Phosphorus Load (lbs/yr)**
Gracelawn	140
Lake shore Drive, East	209
Lake Shore Drive, West	122
Little Wilson Pond	258
Mud Pond	464
North Auburn	247
Route 4	132
Spring Road	447
Summer Street	145
The Basin	606
Townsend Brook	632
West Auburn Road	118
Youngs Corner	169
Total	**3688**

Table 2-18. Buildout Scenario 1 Phosphorus Load by Town	
Town	**Phosphorus Load (lbs)**
Auburn	2831
Buckfield	46
Hebron	40
Minot	172
Turner	598
Total	**3688**

Table 2-19. Buildout Scenario 1 Phosphorus Load by Source	
Source	**Phosphorus Load (lbs)**
Land-based Runoff	
Hay/Pasture	*449*
Cropland	*1812*
Forest	*5*
Wetland	*6*
High Intensity Development	*274*
Low Intensity Development	*180*
Land-based Runoff Subtotal	2725
Other Land-based	
Streambank Erosion (sediment)	74
Baseflow	442
Septic Systems	447
Other Land-based Subtotal	963
Land-based Runoff & Other Land-based Subtotal	3688
Other Sources	
Precipitation	*444*
Internal Recycling	*911*
Other Sources Subtotal	1355
Total	**5043**

Scenario 2. Buildout Under Existing Zoning With Less Stringent Septic Requirements

Scenario 2 is identical to Scenario 1 with one exception: this scenario assumes that septic systems can be built on land with shallow depths to groundwater. The same assumptions as outlined above apply, with the exception that development may occur on properties with less than 36 inches to groundwater. This scenario was evaluated to determine the impacts of less stringent septic requirements within the Lake Auburn watershed.

Under this scenario, an additional 264 acres of land can be developed. Overall development under this scenario includes an existing 41 homes located within 50 feet of the shoreline, an existing 39 homes between 50 and 100 feet of the shoreline and 383 homes between 100 and 300 feet of the shoreline (207 existing homes, 176 additional homes during buildout).

The increased phosphorus loading from septic systems from Scenario 1 is 225 pounds of phosphorus. The increased loading from other sources, associated with the development of these properties (e.g., surface runoff, streambank erosion, etc.) is 125 lbs of phosphorus, resulting in a total phosphorus loading to Lake Auburn of 5,395 lbs. This corresponds with an in-lake concentration of 17.3 µg/l in Lake Auburn. The results of the analysis are summarized in Tables 2-20 by subwatershed, 2-21 by source and 2-22 by Town.

Table 2-20. Buildout Scenario 2
Phosphorus Load by Subwatershed

Subwatershed	Phosphorus Load (lbs)
Gracelawn	142
Lake shore Drive, East	221
Lake Shore Drive, West	126
Little Wilson Pond	262
Mud Pond	463
North Auburn	447
Route 4	129
Spring Road	475
Summer Street	145
The Basin	658
Townsend Brook	683
West Auburn Road	142
Youngs Corner	147
Total	**4041**

Table 2-21. Buildout Scenario 2
Phosphorus Load by Town

Town	Phosphorus Load (lbs)
Auburn	3183
Buckfield	44
Hebron	40
Minot	173
Turner	599
Total	**4041**

Table 2-22. Buildout Scenario 2 Phosphorus Load by Source	
Source	**Phosphorus Load (lbs)**
Land-based Runoff	
Hay/Pasture	*449*
Cropland	*1931*
Forest	*4*
Wetland	*6*
High Intensity Development	*274*
Low Intensity Development	*186*
Land-based Subtotal	2850
Other Land-based	
Streambank Erosion (sediment)	82
Baseflow	438
Septic Systems	671
Other Land-based Subtotal	1191
Land-based Runoff & Other Land-based Subtotal	4041
Other Sources	
Precipitation	*444*
Internal Recycling	*911*
Other Sources Subtotal	1355
Total	**5395**

Scenario 3. More Likely Buildout Scenario

A third buildout scenario was evaluated to represent more likely buildout conditions considering that agricultural in Maine are declining rather than increasing making it unlikely that all of the agriculturally zoned land will be deforested for farming purposes. Under this scenario, the same assumptions as in Scenario 1 were applied, including one house per 10 acres in the agriculturally zoned areas, however, it was assumed that only half of the remaining (e.g., not occupied by the residence) land would be developed as agricultural with the other remaining as forested. This is still believed to be a conservative assumption considering farm lands are declining, however, does anticipate that some of the forested land will be cleared, which is likely to happen in the future whether for agriculture or another use.

Based on this scenario, the lake will receive 4,192 pounds of phosphorus per year, which results in an in-lake phosphorus concentration of 13.4 µg/l. The results of the analysis are summarized in Tables 2-23 by subwatershed, 2-24 by Town and 2-25 by source. This scenario will be used as the basis for future recommendations.

Table 2-23. Buildout Scenario 3 Phosphorus Load by Subwatershed	
Subwatershed	**Phosphorus Load (lbs)**
Gracelawn	92
Lake shore Drive, East	147
Lake Shore Drive, West	73
Little Wilson Pond	251
Mud Pond	463
North Auburn	199
Route 4	132
Spring Road	332
Summer Street	89
The Basin	419
Townsend Brook	443
West Auburn Road	71
Youngs Corner	124
Total	**2837**

Table 2-24. Buildout Scenario 3 Phosphorus Load by Town	
Town	**Phosphorus Load (lbs)**
Auburn	1980
Buckfield	46
Hebron	40
Minot	172
Turner	599
Total	**2837**

Table 2-25. Buildout Scenario 3 Phosphorus Load by Source	
Source	**Phosphorus Load (lbs)**
Land-based Runoff	
Hay/Pasture	*449*
Cropland	*938*
Forest	*9*
Wetland	*6*
High Intensity Development	*274*
Low Intensity Development	*180*
Land-based Runoff Subtotal	1855
Other Land-based	
Streambank Erosion (sediment)	79
Baseflow	456
Septic Systems	447
Other Land-based Subtotal	981
Land-based Runoff & Other Land-based Subtotal	2837
Other Sources	
Precipitation	*444*
Internal Recycling	*911*
Other Sources Subtotal	1355
Total	**4192**

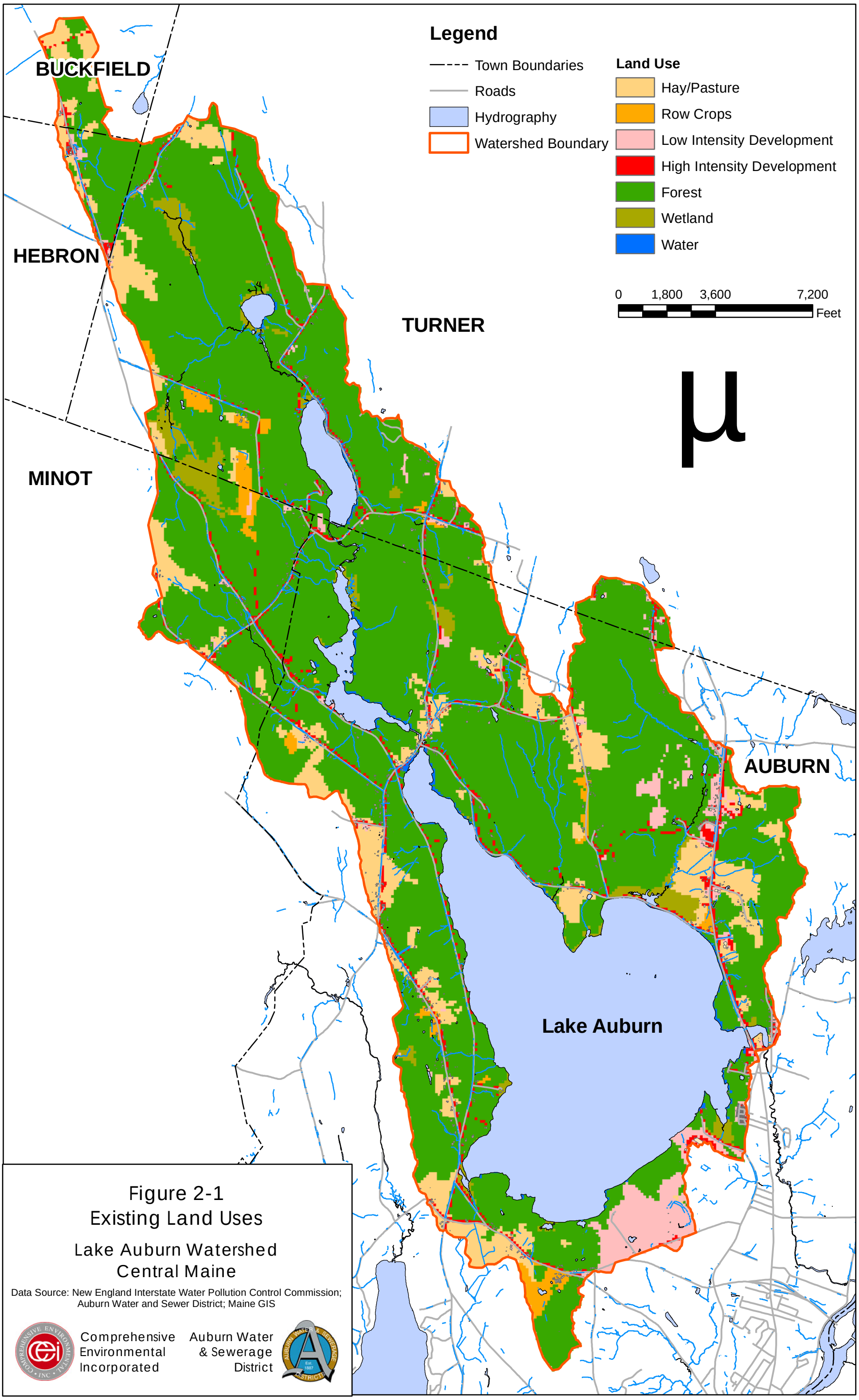


Figure 2-1
Existing Land Uses

Lake Auburn Watershed
Central Maine

Data Source: New England Interstate Water Pollution Control Commission; Auburn Water and Sewer District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

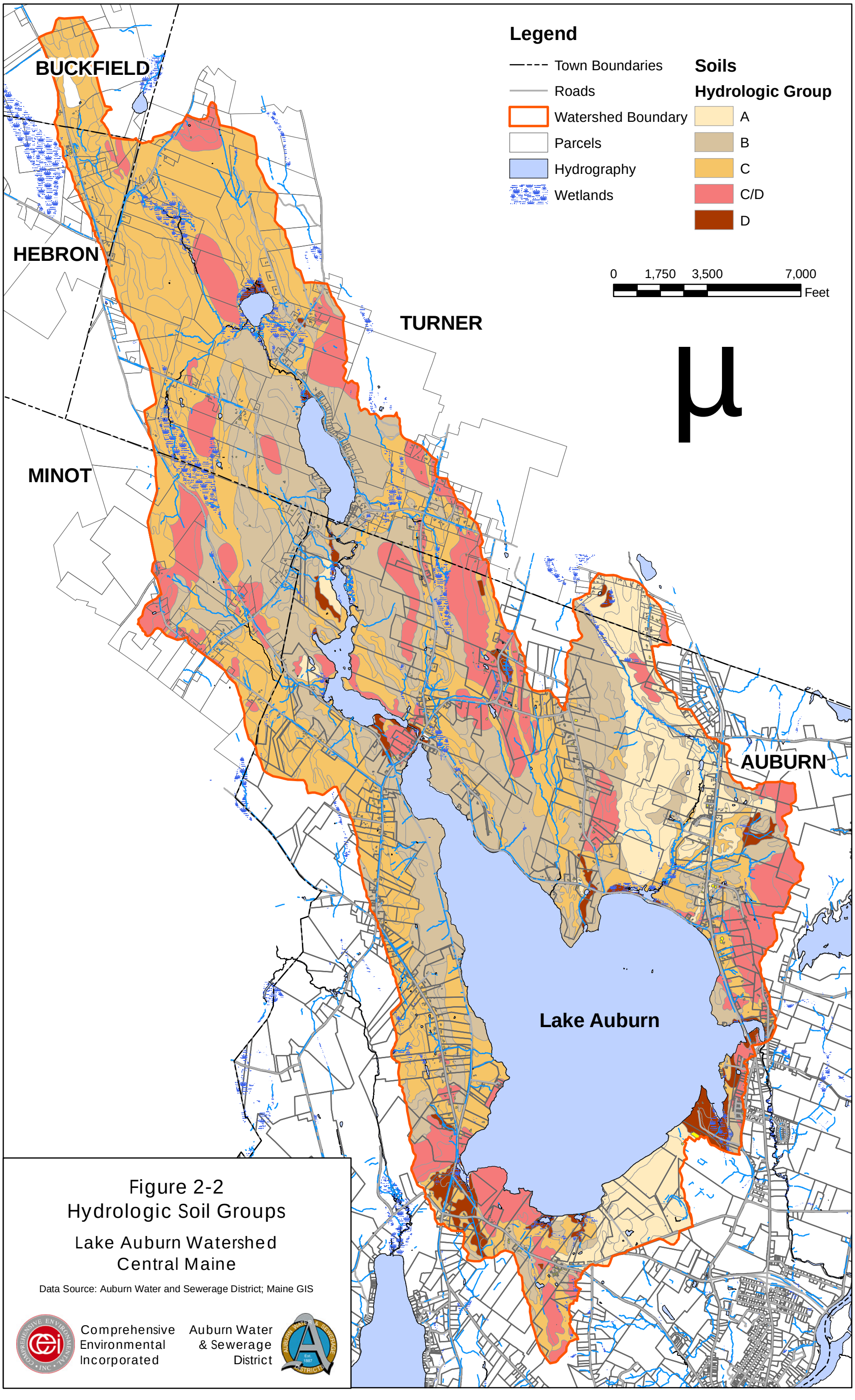


Figure 2-2
Hydrologic Soil Groups

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

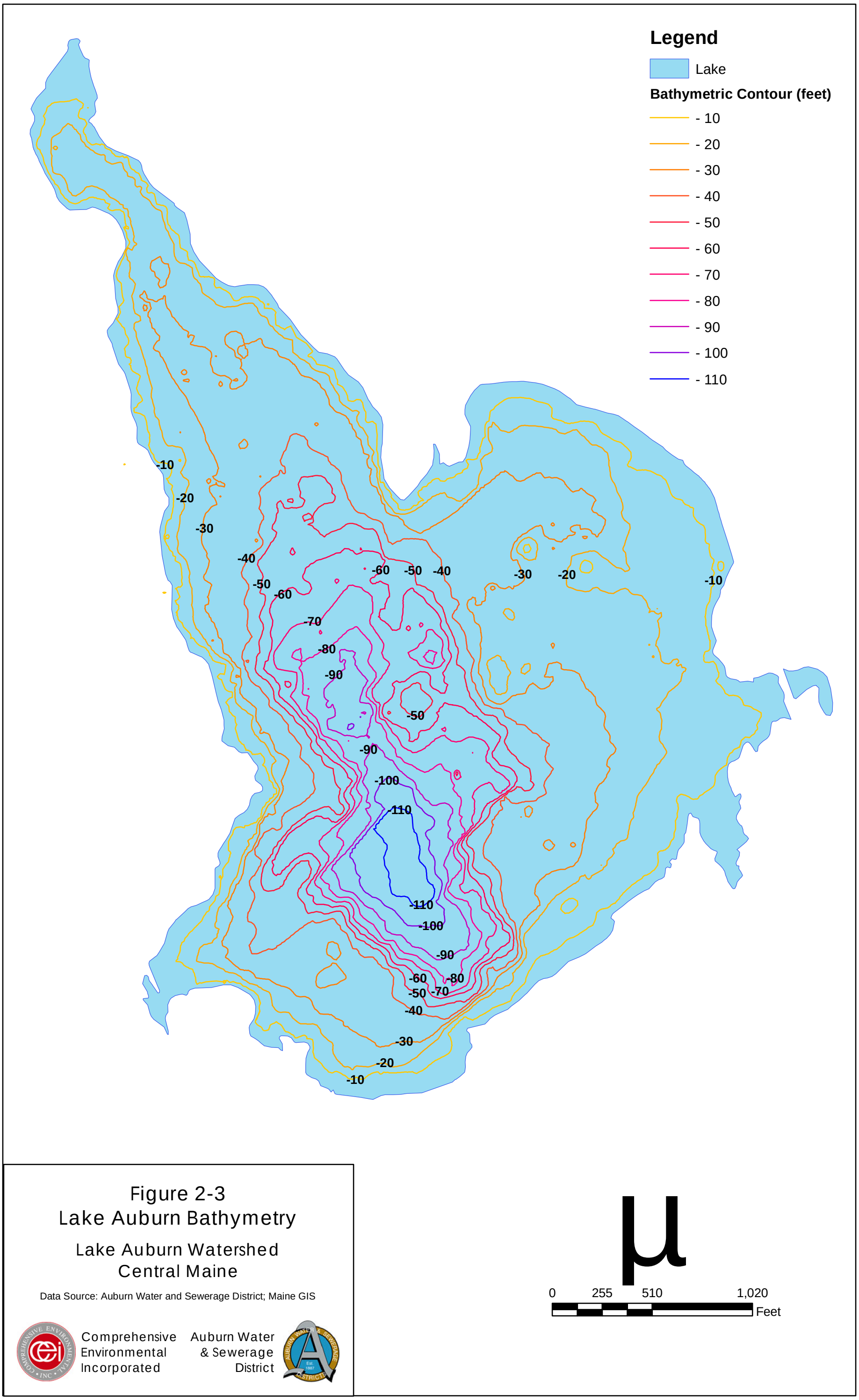


Figure 2-3
Lake Auburn Bathymetry

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Comprehensive Environmental Incorporated

Auburn Water & Sewerage District

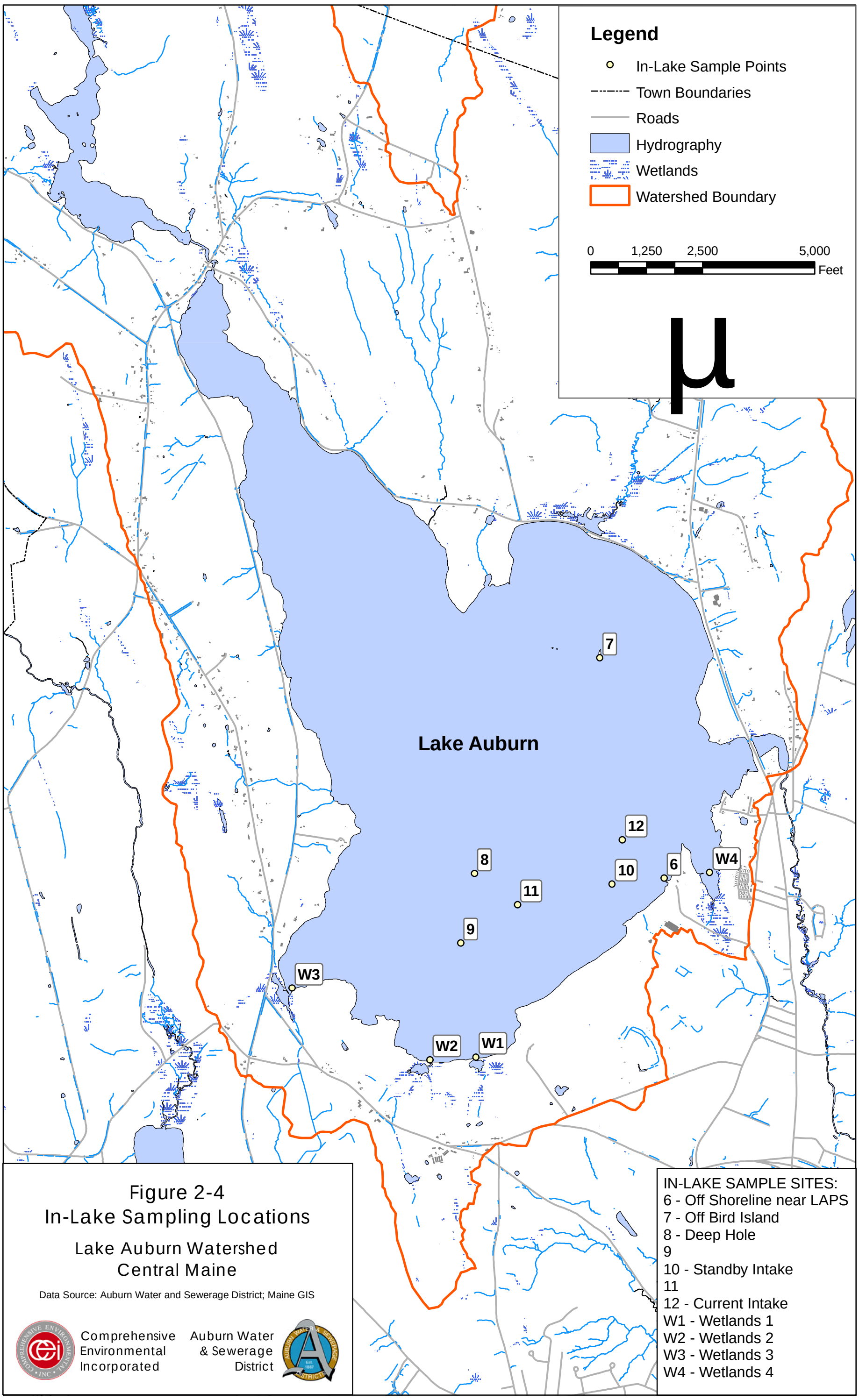


Figure 2-4
In-Lake Sampling Locations

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

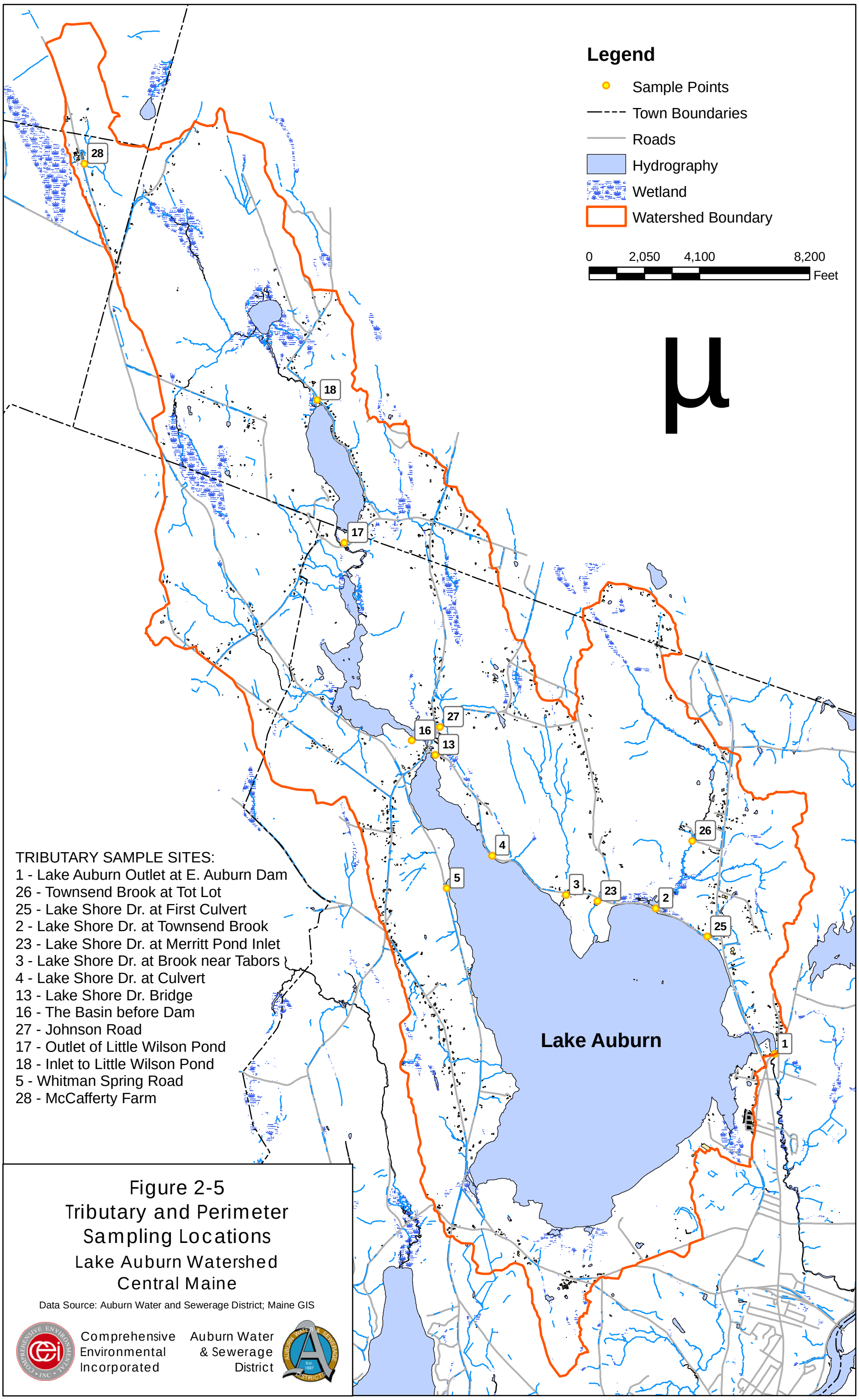


Figure 2-5
Tributary and Perimeter Sampling Locations
Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

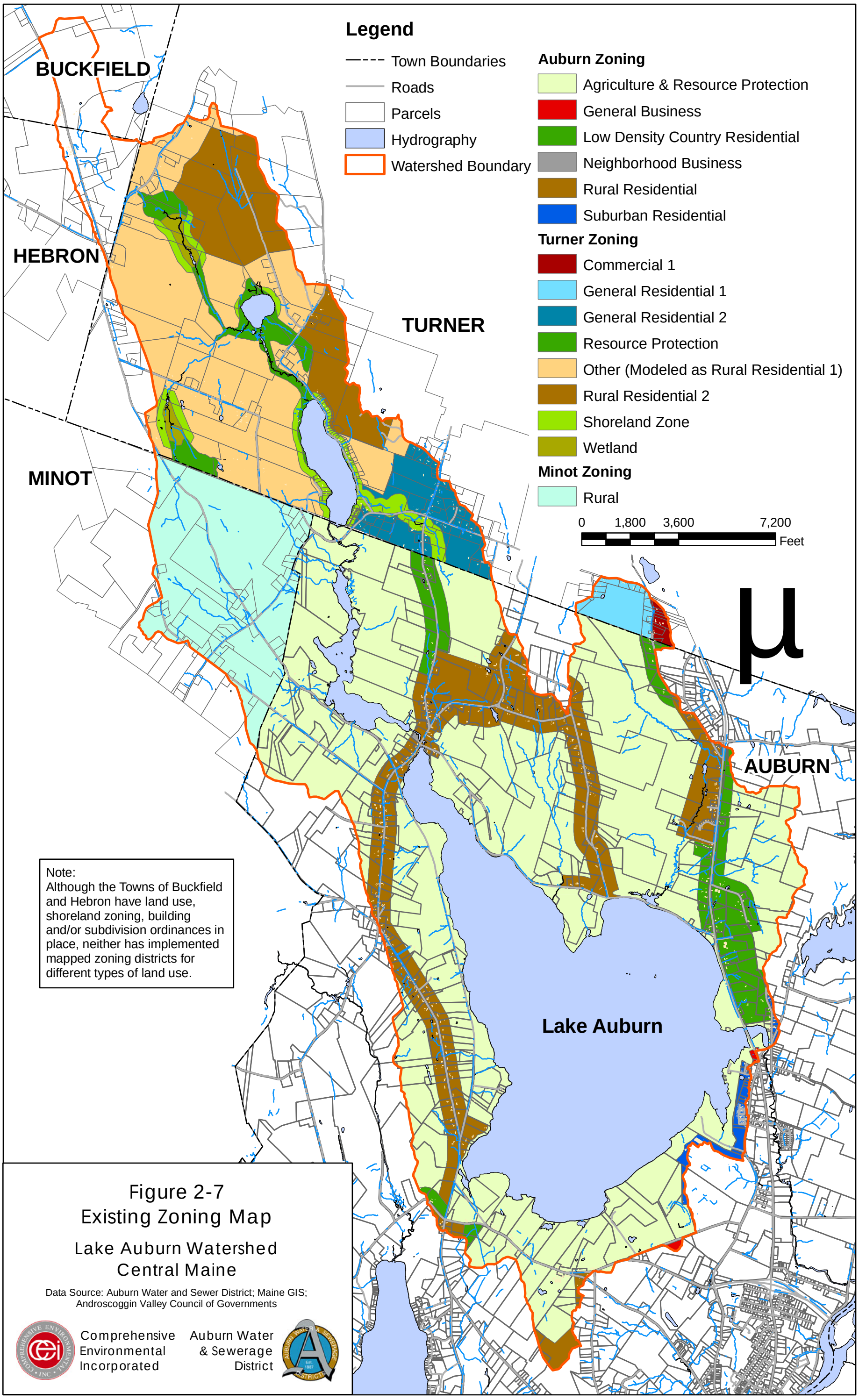


Figure 2-7
Existing Zoning Map

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewer District; Maine GIS; Androscoggin Valley Council of Governments

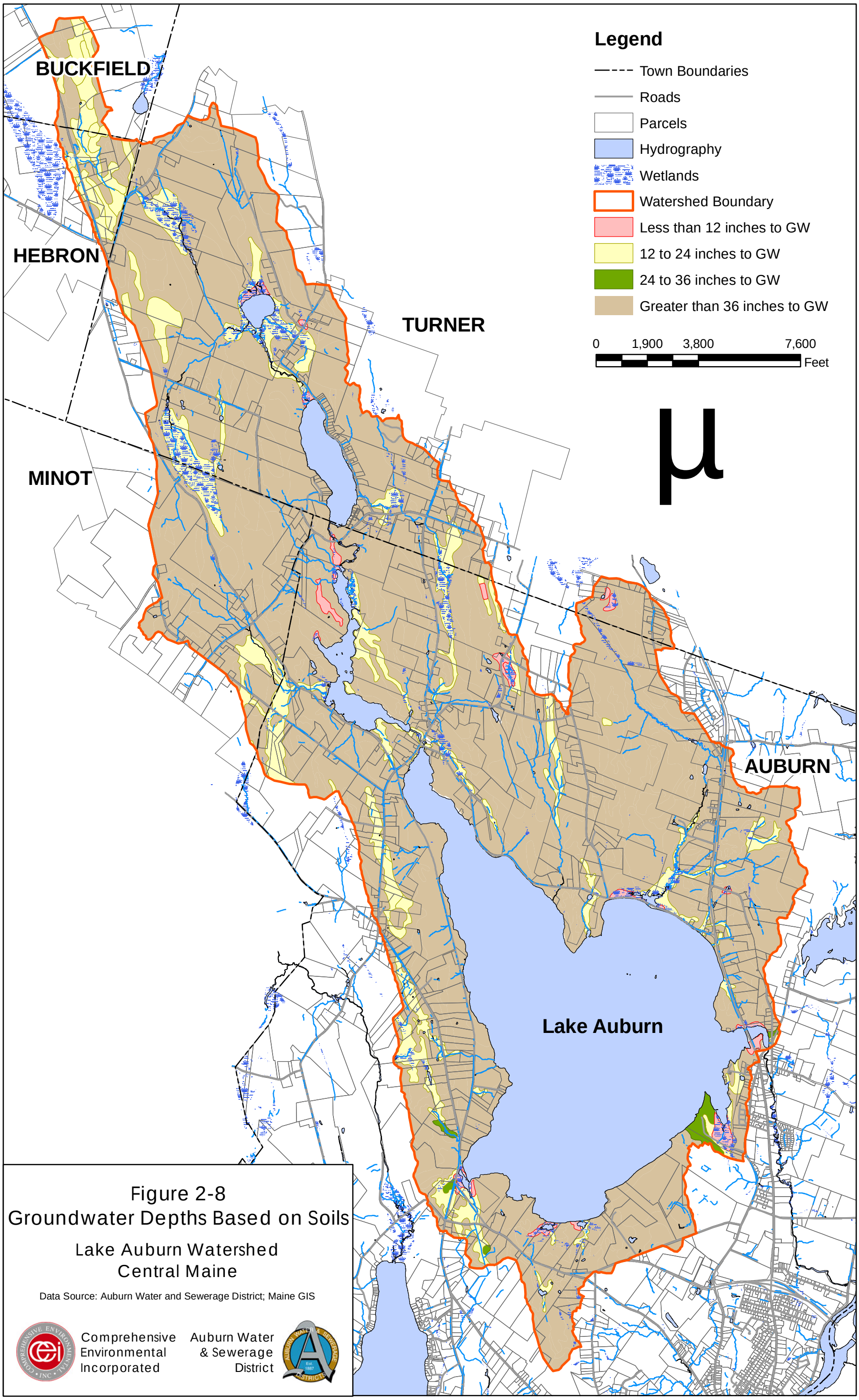


Figure 2-8
Groundwater Depths Based on Soils

Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

3.0 Water Quality and Pollutant Removal Goals

Numeric targets or water quality goals are typically set as the desired water quality to achieve a particular use for a water body (e.g., recreational uses, drinking water). These targets provide a benchmark to dictate and measure the actions needed in the associated watershed to achieve such goals. There are several steps to effective water quality goals, which include:

1. measuring or estimating existing and future water quality and pollutant loadings;
2. identifying the most critical measurement point;
3. identifying the appropriate water quality surrogates or indicators[1];
4. identifying the desired water quality;
5. comparing the existing pollutant loadings to desired water quality goals; and
6. identifying how pollutant loads can be addressed to achieve the goals.

The first step, estimation of future pollutant loadings, was described in Section 2.0. Steps 2-4 are described in this section, below. A comparison of the loadings to the goals (Step 5) is discussed in Section 4.0. The recommended actions to reduce pollutant loads and achieve the goals (Step 6) are discussed in Section 5.0.

3.1 Critical Measurement Point

Setting water quality goals and the effective evaluation of maintaining goals require one critical measurement point for watershed monitoring. It is recommended that water quality in Lake Auburn be assessed at its deepest location, with the collections of top, middle and bottom samples under stratified conditions. Actual in-lake measurements may vary widely from year to year due to climatic factors. Due to these variations, the evaluation of maintaining water quality goals will employ the overall average and data trends.

3.2 Water Quality Surrogates and Indicators

Phosphorus is considered a limiting nutrient for plant life in fresh water systems, and is thereby effective as a primary indicator of overall water quality. Available information for Lake Auburn water quality includes existing phosphorus concentrations, which help in assessing the overall water quality of the lake and calibrating the modeled pollutant loads. Excess phosphorus can cause excess algae blooms and, subsequently, fish die-off. Increased algal growth can also lead to increased turbidity, taste and odor problems in the drinking water. Correction of these water quality issues often requires expensive treatment.

3.3 Desired Water Quality

The epilimnion layer of Lake Auburn, or the top-most layer of the Lake when thermally stratified, contains the phosphorus available for algal growth. Based on the accumulated historic water quality data (described in Section 2.0), the seasonal average water quality in the epilimnion layer ranges between 7 µg/l in the summer and 11.1 µg/l in the winter with an annual average of

[1] A 'surrogate' or 'indicator' parameter is something that represents the general water quality of the lake and that can be reliably measured and tracked.

9.8 µg/l and an average spring phosphorus concentration of 10.3 µg/l. Based on the trophic state evaluation presented by Reckhow[2], the trophic status of a lake can be estimated based on the lake concentration as shown in Table 3-1.

Table 3-1. Proposed Relationships Among Phosphorus Concentration, Trophic State, and Lake Use for North Temperate Lakes
(Adapted from Chapra and Reckhow, 1979; Dillon and Rigler 1975)

Phosphorus Concentration (µg/l)	Trophic State	Description	Lake Use
<10	Oligotrophic	Bodies of water that contain relatively little plant life or nutrients and are rich in dissolved oxygen.	Suitable for water-based recreation and propagation of cold water fisheries, such as trout. Very high clarity and aesthetically pleasing.
10-20	Mesotrophic	Bodies of water having a moderate amount of dissolved nutrients.	Suitable for water-based recreation but often not for cold water fisheries. Clarity less than oligotrophic lake.
20-50	Eutrophic	Bodies of water that are rich in nutrients, resulting in increased plant life (e.g., algal blooms). The bottoms of such waters typically have low dissolved oxygen.	Reduction in aesthetic properties diminishes enjoyment from body contact recreation. Generally very productive for warm water fisheries.
>50	Hypereutrophic	Bodies of water that are very rich in nutrients, resulting in frequent and severe nuisance algal blooms and low transparency.	A typical "old-aged" lake in advanced succession. Some fisheries, but high levels of sedimentation and algae or macrophyte growth may be diminishing open water surface area.

Source: Reckhow, Kenneth H. and Chapra, Steven C. 1983. Engineering Approaches for Lake Management. Volume 1: Data Analysis and Empirical Modeling. Butterworth Publishers. Boston. p.275.

Based on Table 3-1, Lake Auburn is bordering between oligotrophic and mesotrophic. According to the 2003 Source Water Assessment prepared by Maine DEP, Lake Auburn has been classified as mesotrophic by the State.

Lake Auburn has sustained a phosphorus concentration near 10 ppb over the last two decades, and as a result has produced good quality drinking water. While general guidelines indicate

[2]Reckhow, Kenneth H. and Chapra, Steven C. 1983. Engineering Approaches for Lake Management. Volume 1: Data Analysis and Empirical Modeling. Butterworth Publishers. Boston. p.275.

eutrophication to occur at around 20 ppb, each lake is different and will react differently to varying concentrations of phosphorus. Thus, the exact "tipping point" or concentration at which the water quality is considered significantly impaired cannot be generally defined. Increased phosphorus loads and concentrations in the lake will result in greater production of algae and aquatic plants and the following undesirable changes can occur:

- Excessive algae growth – as the algae die, they fall to the bottom of the lake as dead organic matter. The process of decomposition by bacteria of this organic matter at the bottom of the lake uses valuable oxygen in the deeper, colder waters of lake. Many lakes with phosphorus and algal population problems become anoxic in the summer, meaning that there is no oxygen in the deep waters of the lake. This can put many cold-water species at risk of death, or extinction. Plant production also increases the pH of water, which can increase the amount of phosphorus from sediment, creating a long-term internal source of phosphorus for plant growth.
- Reduced water clarity – reduced clarity or increased turbidity is caused by particles suspended or dissolved in water and can include sediment, fine organic and inorganic matter, soluble colored organic compounds, algae and other microscopic organisms. High turbidity can significantly reduce the aesthetic quality of lakes and streams and increase the cost of treatment for drinking water. Turbidity is often used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present) and can make disinfection of these organisms more difficult and expensive, as viruses and bacteria can hide behind the particles.
- Unpleasant odor and taste – increased algal blooms associated with increased phosphorus levels can result in taste and odor changes to the drinking water, increasing customer complaints.
- Low dissolved oxygen – as described above, increased algal blooms and die-off can result in low dissolved oxygen levels at the bottom of the lake, which can result in fish kills and release of sediments and their pollutants.
- Changes in fish populations or fish kills – fish kills may result from low dissolved oxygen levels created from the die-off and decomposition of excessive plant materials associated with the increased phosphorus.
- Toxins from bluegreen algae – cyanobacteria blooms or blue-green algae blooms may become more frequent. These types of blooms produce toxins, which are irritating when contacted directly and have been known to kill animals that drink the raw water. It is also more difficult and expensive to treat raw water with cyanobacteria blooms.

Due to the risks associated with increases in phosphorus loads and in-lake phosphorus concentrations, a water quality goal of 10 µg/l was selected for Lake Auburn. Anything more could result in increased plant production, turbidity and the problems identified above. Given that the Water Utilities of Auburn and Lewiston have a filtration waiver, which was previously put at risk due to bacteria problems associated with seagulls on the Lake, they cannot afford to risk increasing the phosphorus levels and potential water quality impacts associated with such increases.

3.4 Pollutant Removal Goals

Because Lake Auburn currently contains phosphorus near concentrations of 10 µg/l, watershed protection efforts will focus on minimizing pollution from future sources as further development occurs in the watershed. As shown in Section 2.0, the in-lake concentration will likely increase to 13.4 µg/l (more likely buildout scenario 3), solidly placing the lake into a mesotrophic state. This increase in phosphorus could lead to more algal blooms and associated water quality problems.

Maintenance of the water quality goals will require the removal or suppression of pollutant loadings to the Lake under buildout conditions. Table 3-2 shows phosphorus loadings under more likely buildout conditions and required pollutant removal to maintain in-lake phosphorus concentrations of 10 µg/l. The existing low levels of development and in-lake phosphorus concentrations of phosphorus offers greater opportunity to institute pollution reduction controls for future development and determine the best watershed development scenarios to allow growth while minimizing pollutant loads.

Table 3-2. Proposed Phosphorus Loading Goals (Based on Buildout Scenario 3)

Source	Phosphorus Load (lbs)	Target Phosphorus Removal (lbs)	Target Phosphorus Loading (lbs)
Land Based Runoff			
Hay/Pasture	*449*		
Cropland	*938*		
Forest	*9*		
Wetland	*6*		
High Intensity Development	*274*		
Low Intensity Development	*180*		
Land Based Runoff Subtotal	1855		
Other Land Based			
Streambank Erosion (sediment)	*79*		
Baseflow	*456*		
Septic Systems	*447*		
Other Land Based Subtotal	981		
Land Based Runoff & Other Land Based Subtotal	2837		
Other Sources			
Precipitation	*444*		
Internal Recycling	*911*		
Other Sources Subtotal	1355		
Total	**4192**	**1035**	**3157**

4.0 Top Potential Pollutant Sources

The existing water quality of Lake Auburn, as presented in Section 2.0, shows that existing land uses within the watershed are compatible with the lake protection required for a surface drinking water supply. Review of the data shows that phosphorus concentrations in the Lake have remained relatively consistent over the last 20 years. This is due in part to the amount of protected and undeveloped lands within the watershed.

While some sources of pollution currently exist in the watershed, future development is the largest potential threat to water quality. Development increases areas of impervious surface, which in turn increase the amount of stormwater runoff. This runoff enters the Lake and its tributaries as warmed surface flow rather than as clean, cool baseflow provided by undeveloped lands. The buildout analysis in Section 2.0 predicts a 33% increase in phosphorus loads and an associated 30% increase in the in-lake phosphorus concentration (Buildout Scenario 3 – more likely buildout), considering the current phosphorus allocation limits imposed by the State regulations and local ordinance for new development (no limitations on agricultural).

This section presents the top potential pollutant sources based on a review of the watershed and the pollutant model analysis. Recommendations to address these pollution sources are included in Section 5.0.

4.1 Direct Stormwater Discharges

Direct stormwater discharges to the Lake, such as those along Route 4, provide a direct route for contaminated stormwater to enter the Lake. In the case of the stormwater outfalls along Route 4, typical stormwater runoff pollutants such as salt, oil and grease and nutrients (e.g., nitrogen, phosphorus, bacteria) have direct entry into the Lake without any treatment through buffers or wetlands provided in the upper reaches of the watershed. Additionally, the greater traffic load on this route increases the potential for chemical spills associated with vehicle accidents, leaving little time for response to a release before it enters the Lake. Stormwater best management practices can help alleviate this issue by treating stormwater runoff before it enters the Lake.

4.2 Shoreline Erosion

Several locations along Lake Shore Drive show shoreline erosion, which allows sediments to enter the Lake. Sediment loads can eventually contribute to filling in a waterbody, also carrying phosphorus that attaches to the particles. Much of the shoreline erosion observed in the watershed is associated with vehicle and pedestrian access to the lake, disturbing vegetated surfaces and leaving soils exposed for erosion. This can be improved through stabilization techniques that incorporate permanent access ways for continued pedestrian and vehicle traffic.

4.3 In-Lake Sources of Phosphorus

As shown in Section 2.0, internal recycling of sediment may be a source of phosphorus loading to the Lake.

Calculations performed under aerobic conditions, as exist in Lake Auburn, show a significant potential release of phosphorus from the sediments, based on the elevated phosphorus levels in the hypolimnion layer under stratified conditions. Although the relatively high dissolved oxygen levels in the hypolimnion layer under stratified conditions would indicate that internal recycling of sediments is not expected to be an issue, phosphorus data collected from the epilimnion layer in 2005 shows an increase in phosphorus levels after lake-turnover in the fall with levels increasing from 10 ppb up to 14 ppb, pointing to an internal source. Based on the well-oxygenated deep waters in the hypolimnion layer under stratified conditions and limited phosphorus data collected from the hypolimnion profile, it is unclear whether this internal recycling is coming from the bottom sediments or from above the thermocline, where algae may die and settle under stratified conditions, only to be mixed into the water column during turnover. Whatever the source, the 2005 data did show some influence from internal phosphorus recycling. This same trend could not be confirmed for other years. However, the overall settling of phosphorus in the Lake appears to be greater than any internal contribution.

4.4 Septic Systems

Septic systems can contribute pollution to Lake Auburn whether they are failing or not. Contaminants of concern include phosphorus, nitrogen, bacteria, viruses and emerging contaminants such as pharmaceuticals and other endocrine disruptors. Failing systems are of greatest concern, as they can provide a direct discharge of any of these contaminants.

Properly operating systems can also contribute contaminants. Nitrates in particular are extremely soluble and readily enter groundwater for transport to surface systems, where they provide a food source for algal growth. Unlike nitrates, phosphorus has a high affinity for soils and readily attaches to soils as wastewater filters through the soils. However, the soils have a finite capacity for phosphorus uptake and phosphorus will continue to migrate as the soil capacity is used up.

Pharmaceuticals and other endocrine disruptors are also a concern. Although not currently regulated, they have been detected in the environment and linked to sewage outflows.[1][2][3]

4.5 Future Development

Future development has the greatest potential impact on the lake as shown through the modeling results presented in Section 2.0 and as described below:

Residential

The conversion of forested lands to residential lands increases the pollutant load to the lake. There is an increased potential for soil erosion to reach the lake during construction activities,

[1] American Water Works Association. Endocrine Disruptors/PPCPs. Retrieved September 14, 2009 from http://www.awwa.org/Resources/topicspecific.cfm?ItemNumber=3647&navItemNumber=1580

[2] USGS. Endocrine Disruption. Retrieved September 14, 2009. http://biology.usgs.gov/contaminant/endocrine disruptions.html

[3] Silent Spring Institute. Water Research. Retrieved September 11, 2009 from http://s20428.gridserver.com/our-research/water-research

introducing sediment loads and pollutants such as phosphorus attached to this sediment. Increased lawn and garden areas result in increased use of fertilizers in the watershed, with higher loads of nutrients such as phosphorus and nitrogen reaching the lake. Additional impervious surfaces associated with roofs and driveways lead to an increase in stormwater runoff and associated decrease in clean, cool baseflow reaching the lake. The increased stormwater runoff carries greater pollutant loads to the lake.

New development also increases the number of septic systems in the watershed, increasing the total wastewater load to groundwater and ultimately to the lake.

The impacts from new residential development can be lessened through ordinance controls that require treatment of stormwater runoff and through septic system design criteria that maximize pollutant removal and require proper operation of systems.

Agricultural

About 60% of the watershed (75% of the Auburn portion of the watershed) is zoned for agricultural-natural resource development, which does allow agricultural uses within this zone. Concerns associated with agricultural uses include:

- Increased nutrient loads to the lake through the application of fertilizers on crops
- Introduction of pesticides to the lake through the application on crops
- Soil erosion associated with soil disturbance such as during planting and harvesting, introducing nutrient-laden soils into the lake
- Bacteria and nutrient loads from livestock wastes

Agricultural property owners are regulated by the Department of Agriculture, Food and Rural Resources and receive assistance from the Maine Soil and Water Conservation Districts (SWCD) and the United States Department of Agriculture Natural Resources Conservation Service (NRCS). These programs assist with the development of Management Plans to control runoff and pollutant loads from these properties.

4.6 Wildlife

Fecal matter from wildlife can be a source of bacteria and nutrients entering the Lake. Of notable concern in the Lake Auburn Watershed is a gull population that requires consistent control to prevent significant levels of fecal matter from entering the raw water and violating State and federal water quality standards. Gulls were found to be responsible for raw water fecal coliform violations in 2004. The fecal coliform violations nearly resulted in the requirement for filtration as a treatment method. However, AWD and LWD quickly identified the gulls as the cause of violations and a Gull Management Program was developed and implemented with USDA Wildlife Services. The program uses an integrated wildlife damage management approach including lethal and non-lethal harassment of gulls. Since gull management began in the fall of 2005, the bacteria levels have remained in compliance with EPA standards, allowing the Auburn Water District and Lewiston Water Division to retain their filtration waiver. Continuing control of this source of bacteria is necessary to retain the waiver.

5.0 Recommendations

5.1 Introduction

As was described earlier, the health of the lake is affected by many factors. One indicator of lake health often used is total phosphorus concentrations. Lake Auburn's average surface phosphorus concentrations are quite low at 9.8 µg/l annually and 10.3 µg/l in the spring. While these concentrations are desirably low, the lake is sensitive to change due to its long residence time, so it is important to closely watch any increases.

The approximate concentration of 10 ug/l comes from a total average annual phosphorus loading from the watershed and from sediment release of about 3,200 pounds . This load will increase the in-lake phosphorus concentration to 13 ug/l under the most likely buildout scenario (Buildout Scenario 3) if steps are not taken to limit these loadings. The result in increased P loads is increased algal blooms, turbidity, and taste and odor problems. These problems are more than a nuisance though, and could require expensive treatment in the future. Turbidity in particular can "hide" pathogens from the disinfection process. Cyanobacteria (a type of algae) are tough to treat. Increases in one pollutant are also likely to mean increases in other pollutants, as more development occurs in the watershed with greater lawn and impervious areas. These increased pollutant loads have the potential of compromising the Auburn Water District's and Lewiston Water Division's filtration waiver if it is allowed to reach the lake.

Fortunately, the Lake Auburn Watershed Protection Commission (LAWPC) has worked long and hard to prevent the degradation of lake water quality, knowing that it is much easier and less expensive to maintain water quality than it is to restore it. The programs already in place, with added protections, will provide LAWPC all the tools and flexibility needed to protect the watershed into the future. But continued vigilance and adaptation to new threats is needed for success.

If the current in-lake concentration at 10 µg/l is to be maintained over time, increases in phosphorus must be held to a minimum. The buildout analysis shows that a total of 1,035 pounds of phosphorus must be prevented from entering the lake under the more likely buildout conditions. The most effective way to do this is to use stormwater controls and treatment, since stormwater carries phosphorus loads to the lake. Stormwater also represents an estimated 44% of the total potential future loadings of phosphorus to the lake. Other controls are also included where appropriate and cost effective.

This section describes an implementation program that will help maintain the existing lake water quality in its pristine condition. Recommendations are presented below, in no specific prioritized order, and shown on Table 5-1 at the end of the section in terms of costs, schedule and phosphorus removal rates. Note that although most recommendations relate to phosphorus removal, some recommendations are critical even though they do not directly remove phosphorus as this is simply an indicator of lake health but does not represent the whole picture.

5.2 Recommendations

#1 Promote the Use of Low Impact Development (LID) Techniques for Development and Redevelopment

Auburn currently requires peak control of the 2-, 10 and 25- year storms and control of phosphorus inputs to the lake in accordance with the Phosphorus Control Ordinance. While this controls stormwater flow rates from larger storms in an effort to prevent flooding, it does not address flow volumes. The use of LID techniques helps to maintain the natural hydrologic cycle by handling water where it falls rather than end of pipe types of controls. Where applicable, this promotes greater stormwater infiltration and less stormwater runoff, maintaining cool, clean groundwater base flow to the Lake, while minimizing warmer, less clean stormwater discharges to the Lake. The Lake Auburn Watershed is unique from other areas in Maine in that it does have a significant amount of coarse soils, providing more flexibility to infiltrate and control not only pollutant loads but also flow volumes to help maintain the natural hydrologic cycle.

While beneficial in all areas of the watershed, the use of these controls in the Basin's direct watershed will help minimize stormwater runoff and sediment loads to the Basin. The Basin, located in the northern portion of the watershed, is a dammed impoundment that essentially acts as a sediment forebay/detention basin for the flows entering Lake Auburn from this area of the watershed. It has done an excellent job at keeping sediments from entering Lake Auburn, as evidenced by the sediment depths within the Basin and behind the dam. As the Basin fills, its removal capabilities are diminished. This is evidenced in the water quality data which shows high levels of phosphorus coming from this area of the watershed. Since dredging of the sediments in the Basin is unlikely to occur, the use of LID controls in the Basin's direct watershed to minimize stormwater runoff and sediment loads to the Basin is a good alternative.

Recommendation: Promote the use of LID techniques and standards for new and redevelopment projects by incorporating LID design standards into the Chapter 32 Design and Construction Standards. The standards should limit impervious areas and promote maintaining the natural hydrologic cycle through the infiltration of stormwater.

Actions:

1) Develop draft language for LID Standards with City Councils and legal counsel.
2) Present proposed changes at a public hearing.
3) Adopt updated ordinance.

Partners: Auburn Water District and Lewiston Water Division, City of Auburn Planning & Permitting Dept., Auburn Planning Board and Auburn City Council

Budgeted Costs: Staff time

Annual Costs: None

#2 Amend Zoning Ordinance to Strengthen Subsurface Wastewater Disposal Requirements

An evaluation of the Section 5.3 of the Auburn Zoning Ordinance pertaining to subsurface disposal system requirements in the overlay district was performed separately but simultaneously with this Watershed Management Plan to investigate whether the ordinance should be modified to allow more lenient septic system design criteria in light of the State's more lenient criteria. The memorandum prepared under this investigation is included in Appendix C.

The key findings of the evaluation were:

1) Other New England States require 3+ feet of vertical separation and at least 2 feet is needed – the soils beneath a leachfield serve to filter pollutants from the wastewater. The greater the vertical distance through the soil, the greater the treatment. Most studies reveal a minimum of 24" vertical separation for adequate pollutant removal, regardless of soil type.
2) The Lake Auburn watershed has coarse soils – The geology of the Lake Auburn watershed is characterized by coarse soils and some gravel, unlike the lodgement (basal) tills found in much of Maine. These coarse materials do not filter pollutants as well as finer materials and may require greater vertical separation distances to treat.
3) Phosphorus, an important pollutant of Lake Auburn, can get to the lake if septic systems are too close – Some studies[1] have found long-term migration of phosphorus in the groundwater zone, with phosphorus above background levels detected up to 250 feet away from the septic system. Nitrate travels rapidly away from septic systems.
4) More lenient septic requirements increases phosphorus loads to Lake Auburn – Both failing and non-failing septic systems can contribute phosphorus and other pollutants to the Lake. Allowing for more lenient septic design requirements within the watershed will allow for the placement of septic systems where they are not currently allowed. This also results in an increase in impervious area in the watershed and increased phosphorus loadings from stormwater runoff.
5) Changes to the Lake Auburn Watershed Overlay District (LAO) ordinance may put the filtration waiver at risk – The LAO and other watershed control programs in place at the time the filtration waiver was granted were key factors in granting the waiver and changes to these programs, particularly changes that allow for more growth and net loadings to the Lake, could put the District at risk for losing that waiver.

Based on these findings and the responsibility of the Auburn Water District and Lewiston Water Division to provide clean, affordable water to its customers, LAWPC should strengthen septic system provisions of Section 5.3 Lake Auburn Watershed Overlay Districts (LAO) of the Zoning Ordinance to improve protection of the Lake.

[1] Special issue: fate of phosphorus in septic tanks (autonomous waste water treatment systems). *Scope Newsletter*. Number 63. January 2006.

Recommendation: Amend Section 5.3 of the Auburn Zoning Ordinance to include the following provisions:

a. Increase the vertical separation to groundwater or restrictive layer from 24" to 36" in sandy soils. Sandy soils provide less effective pollutant removal than finer soils and a greater separation distance will provide more opportunity for pollutant removal in these soils.
b. Require a minimum 300 foot horizontal setback from all waterbodies within the watershed. The current ordinance only requires the 300 foot buffer in sandy soils, with greater buffers for larger systems. As a point of reference, York, Maine, requires a setback of 500 feet to a public water supply and 250 feet from all streams to the supply. This helps with the long-term removal of phosphorus associated with wastewater.
c. Require periodic inspection of existing septic systems in the watershed on a specific schedule. Currently only required for properties within the shoreland zone upon transfer of property (30-A MRSA § 4216 – Transfers of Shoreland Property). The cost of the inspection could be borne by the homeowner, and any identified malfunctions would be further documented by the local plumbing inspector and referred to the elected municipal officials for corrections. This will identify malfunctions sooner than only requiring an inspection at the time of property transfer.
d. Add system maintenance requirements to the ordinance that require residents to pump out their septic tanks on a specific schedule. See Appendix D for a model septic ordinance for operation and maintenance of onsite sewage disposal systems prepared by the Association of New Jersey Environmental Commissions (ANJEC).
e. Require a reserve area for a replacement disposal field in the event of failure. The reserve area ensures a suitable location for replacement at a lower cost to the owner, while also providing fresh soils for pollutant uptake in the event a new system is needed.
f. Require that a septic system must be located on the same lot as the building it serves to prevent the construction of multiple septic systems on one lot, which results in increased flows and an increased potential for pollution to reach groundwater.

Actions:

1) Draft ordinance language changes with City Councils and legal counsel.
2) Present proposed changes at a public hearing.
3) Adopt proposed changes.

Partners: Auburn Water District and Lewiston Water Division, City of Auburn Planning & Permitting Dept., Auburn Planning Board and Auburn City Council

Budgeted Costs: Staff time

Annual Costs: None

#3 Update Phosphorus Control Ordinance

The Maine Department of Environmental Protection (ME DEP) recently updated its "Phosphorus Control and Lake Watershed A Technical Guide to Evaluating New Development" manual in January 2008. The new manual is Volume II of a three volume Maine Stormwater Best Management Practices Manual and includes updated information on calculating the phosphorus removal efficiency of stormwater BMPs based on sizing. LAWPC should replace the reference to the old manual in the ordinance with the new manual reference and update the "Future Area to be Developed (D)" and "Per-Acre Phosphorus Allocation (P)" values in the ordinance to 1,524 acres and 0.036 lbs/acre/yr, respectively.

Recommendation: Replace the reference to the *"Phosphorus Control and Lake Watersheds A Technical Guide to Evaluating New Development" (Maine DEP et-al,., September 1989 with the Simple Review Method revised in May 1990).* in Section 5.7G with a reference to the new manual *"Stormwater Management for Maine, Volume II – Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development". January 2008. Maine DEP No. DEPLW0738 (part II).* Update the (D) value in the ordinance to 1,524 acres and the (P) value in the ordinance to 0.036 lbs/acre/yr to be consistent with the new State requirements.

Actions:

1) Update manual reference and (D) and (P) values in the ordinance.
2) Present proposed changes at a public hearing.
3) Adopt updated ordinance.

Partners: Auburn Water District and Lewiston Water Division, City of Auburn Planning & Permitting Dept., Auburn Planning Board and Auburn City Council

Budgeted Costs: Staff time

Annual Costs: None

#4 Amend Ordinance to Prohibit Certain Land Uses Within the Lake Auburn Watershed Overlay District

Most of the land within the Lake Auburn watershed is zoned "Agriculture and Resources Protection" followed by "Rural Residential" and "Low Density Country Residential" with very little "Neighborhood Business", "General Business" and "Suburban Residential". The Zoning Ordinance identifies the type of land uses that are permitted within each of these zones, and outlines a few that are not allowed within and environmental overlay district or over any known aquifer (e.g., cemeteries, municipal sanitary landfills). LAWPC should consider prohibiting some other uses based on their potential to contaminate the drinking water supply.

Recommendation: Add a section to the LAO portion of the Zoning Ordinance specifying prohibited land uses within the overlay district. Consider prohibiting the following uses:

- Car washing facilities (unless treated/recycled) – Untreated wash water can contain petroleum residues and detergents

- Auto, boat, or other vehicle service and/or repair operations – potential for petroleum and solvent releases
- Bulk chemical outdoor chemical storage (e.g., herbicides, pesticides or fertilizers) – potential for release of large quantities of chemicals
- Sanitary landfills – already prohibited from environmental overlay districts in other areas of the ordinance, repeat here for comprehensive listing
- Cemeteries – already prohibited from environmental overlay districts in other areas of the ordinance, repeat here for comprehensive listing
- Hospitals and elderly care facilities – septage likely to contain large quantities of pharmaceuticals which can enter the water supply. Although not regulated yet, can have impacts on future treatment requirements as regulations change.
- Automobile fuel stations, repair and service stations – potential for release of petroleum and solvents
- Research, experimental, testing laboratories – specifically those that have the potential for chemical release, releases into septic system
- Dry cleaners – potential for perchloroethylene (PCE) release

Actions:

1) Draft ordinance language changes with City Councils and legal counsel.
2) Present proposed changes at a public hearing.
3) Adopt proposed changes.

Partners: Auburn Water District and Lewiston Water Division, City of Auburn Planning & Permitting Dept., Auburn Planning Board and Auburn Town Council

Budgeted Costs: Staff time

Annual Costs: None

#5 Work with the City and Town DPWs to Address Drainage Issues in the Watershed

Some of the drainage within the watershed requires attention. While LAWPC is responsible for protecting the Lake Auburn watershed and water supply, the watershed cities and towns and Maine DOT are still responsible for the maintenance of roadway culverts. This can require a lot of intermunicipal and state coordination to make sure that the maintenance of these structures is done on a priority basis in that DPWs and Maine DOT may have other priorities too.

Where LAWPC is policing the watershed for potential pollution sources, and DPWs and Maine DOT are performing maintenance of drainage structures, it would be beneficial for LAWPC and DPWs and Maine DOT to meet regularly to coordinate and prioritize efforts.

The Auburn Water District recently worked with the Auburn DPW to discuss drainage improvements along North Auburn Road for incorporation into a proposed roadway project to reclaim and reconstruct the North Auburn Road (beginning at the intersection of West Auburn Road & Perkins Ridge Road and ending at the intersection of Skillings Corner Road & Johnson Road, continuing to the Turner town line). Staff from the Auburn Water District walked the entire route of the project with the Auburn DPW to discuss and incorporate drainage

improvements that involve breaking up the culvert discharges along North Auburn Road to better disperse flows, resulting in less concentrated flows at any location. This type of interaction should continue to address other areas of concern, their priority and responsibility for addressing them.

Recommendation: Meet regularly with DPW and Maine DOT staff to discuss drainage issues observed in the watershed that need attention and designate responsibility for maintenance actions.

Actions:

1) Identify issues in the watershed that require attention.
2) Meet with DPW and Maine DOT staff to discuss identified issues, potential solutions and responsibilities.
3) Include potential projects in public education information to keep residents informed of activities to protect the watershed.

Partners: Auburn Water District, Lewiston Water Division, City of Auburn Department of Public Works, Turner DPW, Minot DPW, Hebron DPW, Buckfield DPW, Maine DOT

Budgeted Costs: Staff time

Annual Costs: None

#6 Set Aside Funds for Maintenance of Watershed Lands

Lake Auburn receives a significant amount of protection through the large amount of protected lands in the watershed, particularly along the shoreline, which help buffer pollutants entering the lake, and through the existing ordinances which help minimize pollution from new sources. The LAWPC has also had success in obtaining grant funds to help control the spread of invasive species in the lake and to correct eroding soils that contribute sediment and phosphorus loads to the lake.

While the State grant programs are an excellent opportunity to fund needed projects within the watershed, the LAWPC should also consider setting aside additional funds in the 'Source Protection Management' budget line item. This item currently includes a budget for invasive species control and for work associated with grants, but does not include any money for additional water projects. This will allow the LAWPC to correct any issues found within the watershed that could be a potential problem if not addressed.

For example, funds may be used for watershed protection projects such as the installation of shoreline erosion controls, installation of permanent access ways, removal of impervious surfaces along the shoreline, etc. The funds may also be used to address emergency situations such as handling an accident adjacent to the Lake to prevent contaminants from entering or other situations as they arise.

As the land acquisition policy and program is fulfilled with most of the priority parcels being acquired, LAWPC should consider curtailing some of the land acquisition budget for the purpose of additional watershed maintenance.

Recommendation: Set aside money for the maintenance of watershed lands and to address emergency situations as they arise.

Actions:

1) Include additional funds in the watershed protection item of the LAWPC budget to address erosion and other watershed problems that need attention.
2) Evaluate necessary rate adjustments to include the budget item.

Partners: Auburn Water District, Lewiston Water Division, City of Auburn Department of Public Works

Budgeted Costs: see "Annual Costs" below

Annual Costs: $10,000

#7 Address Direct Stormwater Discharges on Route 4 and Within Other Areas of the Watershed

As shown by the good water quality within the lake, with phosphorus levels remaining relatively stable over the last 20 years, the watershed has been well protected. In addition to its land acquisition program, the LAWPC has implemented several other projects to reduce pollutant loadings to the lake from existing sources. Examples of projects implemented include:

- the conversion of parking areas along the lake side of Lake Shore Drive and North Auburn Road to vegetated areas, with alternate parking provided across the street. This has reduced direct runoff and erosion into the lake and offered a larger buffer for pollutant removal, while still allowing parking and access;
- the stabilization of steep, eroding banks along Lake Shore Drive through vegetation;
- the installation of rip rap along a steep slope down to the water's edge at the Central Maine Community College to prevent erosion of bank soils and restrict access that contributed to the erosion problem;
- the installation of several stormwater best management practices at the Central Maine Community College to collect and treat stormwater runoff from a parking lot that previously discharged through a channel into the lake;
- stabilization of the boat launch at The Basin.

Although on an individual basis these areas may not contribute significant loadings to the lake in comparison to the total watershed-wide loadings, their proximity to the lake adds another level of importance that cannot be quantified solely by pollutant loadings. It is important to maintain adequate buffers to the lake and to minimize direct discharges into the lake, as these direct discharges offer the greatest potential for the introduction of untreated pollutants.

Other direct discharges noted during a review of the watershed include several stormwater outfalls along Route 4 that discharge directly into the lake untreated, carrying pollutants from the highway and surrounding area. In addition to the increased phosphorus loading, these discharges also increase the potential for a chemical spill to enter the lake from a vehicle accident and provide a direct route for eroded sediments to enter the lake. These areas are a priority for implementing stormwater structural controls as they are located close to the intake, offering little retention time in the Lake. This area was identified as an area of concern in the 2003 Source Water Assessment Program with recommendations to implement stormwater BMPs.

Recommendation: Design and install stormwater best management practices (BMPs) to treat stormwater runoff entering the lake from the stormwater outfalls along Route 4.

There are seven stormwater structure/outfall areas along Route 4, four that discharge directly into the Lake and three that discharge on the east side of Route 4 near the outfall as shown and numbered on Figure 5-1. BMPs to treat the stormwater runoff and to provide some level of spill prevention control should be installed in these areas. Some conceptual ideas for BMPs are included in Table 5-2.

Due to the limited space available for implementing BMPs in this area and the steep slopes located on the lake side of the roadway, proprietary BMPs are recommended for a number of these locations, as they typically have smaller surface footprints. Currently, the Maine Department of Environmental Protection (DEP) has approved two proprietary stormwater BMPs as meeting the requirements of the Chapter 500 rules. These include the Filterra System by Americast, which consists of a concrete box filled with an engineered media and planted with a tree (see Appendix E) and the StormTreat System by StormTreat Systems, Inc. (Appendix E). Both of these systems are capable of removing about 65% of the phosphorus load from the highway and can be combined with spill prevention control to protect the Lake from pollutants from Route 4. Another possibility is the Contech Filtration System which DEP is expecting to approve as meeting Chapter 500 standards in the near future.

Additional information such as more detailed topographic contours, estimated groundwater levels, invert elevations and sump depths are needed to select the best BMP for the area.

Table 5-2. Recommended Conceptual Stormwater BMPs for Route 4			
Outfall ID	**Location**	**BMPs**	**Comments**
1	Boat launch area	No Action	Discharges on east side of Route 4.
2	Paved turnaround area	No Action	Outlet was previously directed to east side of Route 4.
3		Deep sump catch basin.	
4		Proprietary treatment device.	Space constraints limit options. These units require frequent maintenance.
5		Proprietary treatment device.	Space constraints limit options. These units require frequent maintenance.
6		Deep sump catch basin.	Space constraints limit options. Deep sump catch basin appropriate for smaller drainage area (single catch basin collection).
7		Proprietary treatment device.	Steep slopes limit surface treatment options.

Actions:

1) Meet with Maine DOT to discuss treatment concepts and maintenance responsibilities.
2) Seek grant funding for design and construction.
3) Prepare final design plans and specifications.
4) Obtain permits.
5) Construct stormwater BMPs.

Partners: Auburn Water District, Lewiston Water Division, Maine DOT

Budgeted Costs: $204,000 for design, permitting and installation

Annual Costs: Staff time for annual maintenance

#8 Supplement Erosion Control Strategies Along Lake Shore Drive and Other Locations Along the Lake

The LAWPC has addressed erosion within the watershed, including The Basin boat launch, a steep bank at the Central Maine Community College and some areas along Lake Shore Drive with some assistance through State grants. This has involved the stabilization of eroded areas using vegetation or other techniques to stabilize the soils. Several eroded areas along Lake Shore Drive still remain to be addressed.

Based on field review and discussions with Auburn Water District, some of the erosion along Lake Shore Drive is caused from vehicle and pedestrian access as people access the shoreline for fishing and viewing, rather than stormwater runoff. In these cases, it may be more appropriate to install permanent access ways that will direct vehicle and pedestrian traffic to desired areas that can withstand this type of traffic, avoiding the disturbance of adjacent vegetation.

Examples of erosion controls that incorporate permanent access structures used in other watersheds are shown in Appendix F.

Recommendation: Address remaining erosion along Lake Shore Drive. When addressing erosion here and within the watershed, evaluate the causes to determine whether some benefit may be provided through the installation of a permanent access way that provides permanent stabilization and accessibility.

Actions:

1) Evaluate the cause of erosion and need for permanent access along Lake Shore Drive and other areas as needed.
2) Prepare conceptual designs for erosion control and access ways.
3) Seek funding.
4) Construct erosion controls and access ways.

Partners: Auburn Water District, Lewiston Water Division

Budgeted Costs: $190,000 for design, permitting and installation. Assumes 1000 linear feet of erosion to be corrected and includes two sets of stairway and 500 square feet of vegetated geogrid for permanent access points).

Annual Costs: None

#9 Increase Vegetated Buffers Around the Lake – Replace Route 4 Paved Turnaround with Vegetation

As discussed under Recommendations #7 and #8, the LAWPC has taken several actions to protect the watershed, including the movement of parking areas along the lake to increase the vegetated buffer to the lake and reduce erosion. This has particularly been the case along Lakeshore Drive.

Route 4 also has an impervious parking area located immediately adjacent to the lake. There is a turnaround located near the existing boat launch parking area, which butts up to the lake. Vehicles use this area to turnaround on the Route and as a stopping point to admire the lakes scenic attributes. Unfortunately, the area is also often used as a dumping grounds for unwanted trash by passerbys.

Since the adjacent boat launch parking area offers access to the lake, while also allowing vehicles to turnaround and parking for drivers to stop and admire the lake, there is no real need for the paved turnaround area on Route 4. In keeping with past practices around the lake, this area should be converted to a vegetated area to minimize the direct runoff associated with it.

Recommendation: Replace the paved turnaround adjacent to the boat launch parking area along Route 4 into a vegetated area.

Actions:

1) Discuss plans with Maine DOT.
2) Develop a landscape plan for the area.
3) Obtain necessary permits.
4) Construct vegetated area.

Partners: Auburn Water District, Lewiston Water Division, Maine DOT, City of Auburn Planning & Permitting Dept., Auburn Planning Board and Auburn City Council

Budgeted Costs: $30,000 to remove existing pavement and replace with plantings assuming loam and seed for 2/3 of area and plants (shrubs) for 1/3 of area.

Annual Costs: None

#10 Public Education

About 7% of the Lake Auburn watershed (excluding waters) is developed as residential development, which produces about 300 pounds or 32% (existing) of the total stormwater phosphorus load to the Lake. This comes from generalized sources such as uncontrolled pet wastes; lawn and garden fertilizers; car washing; and uncontrolled runoff from impervious surfaces such as driveways, roadways, etc. Private septic systems also contribute a phosphorus load to the Lake, about 290 pounds or 16% of the total land-based loading (stormwater runoff and groundwater inputs). These are anticipated to increase under the more likely buildout scenario, with residential contributing about 450 pounds or 24% and septic systems contributing 447 pounds and 16% of the total land-based loading.

Another 12% of the watershed is currently in agricultural use, contributing about 600 pounds or 64% of the stormwater phosphorus load to the Lake. This is anticipated to increase to 1,387 pounds or 75% of the stormwater phosphorus load to the Lake under the more likely Buildout Scenario 3.

A public education program targeting residential, business and agricultural uses can help reduce these sources by keeping residents and farmers informed of the importance of watershed protection, the cost benefits of keeping pollutants out of the lake (e.g., no filtration plant), while emphasizing some of the work the LAWPC is doing to protect the watershed and to share its lands with the public. This approach tackles the source of the pollution rather than expending significant funds on end-of-pipe treatment structures or costly water treatment processes.

A program targeting residents and businesses is anticipated to decrease these loads by 20%, while a program targeting agricultural properties that encourages and results in the use of best management practices such as nutrient management plans and crop rotation can reduce loadings from these properties by 28% (nutrient management) and 36% (crop rotation).

The LAWPC has been involved with public education activities in the past including:

- Preparation and distribution of the annual water quality report, which includes information on watershed protection
- Posting of the annual water quality report on the LAWPC website
- Development and distribution of a newspaper brochure on Lake Auburn as a water supply and ongoing protection measures
- Press releases
- Cooperation with Maine Water Utilities Association (MWUA) including participation in annual tours of lab and treatment plant
- Work with students on science fair projects
- Meeting with watershed property owners

The following components are proposed to expand and build off these activities.

10A. Website

The Auburn Water District, Auburn Sewerage District and Lake Auburn Watershed Protection Commission share a website that provides information on operations, rules and regulations, rates, contact information and answers to frequently asked questions. It also includes a map of the watershed, a copy of the drinking water quality report and some links related to invasive plant species, however, there is no information or links to current and past watershed protection efforts or on the impacts of stormwater runoff and what residents can do to minimize these impacts.

Recommendation: Enhance the existing website to provide information pertaining to the watershed including:

- the impacts of stormwater runoff;
- the importance of watershed protection for maintaining the filtration waiver and the cost benefits of this;
- information on what citizens can accomplish with small changes in how they deal with wastes and rainwater;
- information on how improper use and function of septic systems can impact drinking water supplies, both private and public;
- information on the proper operation and maintenance of subsurface wastewater disposal systems;
- proper fertilizer and pesticide use;
- proper disposal of yard waste;
- proper disposal of pharmaceuticals and personal care products;
- highlight watershed protection projects performed by LAWPC and funding received from outside sources;
- a description of recreation opportunities within the watershed;
- links to other sites regarding stormwater runoff and watershed protection;
- a kids' section linking to the school education program.

Actions:

1) Research tips for citizens to include on the website.
2) Obtain information from the local schools on their education programs.
3) Develop a website containing the information.

Partners: Auburn Water District and Lewiston Water Division

Budgeted Costs: $1,000 for web manager plus staff time to generate materials

Annual Costs: staff time for upkeep of website

10B. Develop and Distribute Educational Materials

The distribution of educational materials can help to keep residents informed of the importance of watershed protection and their role in it, however, one or two periodic mailings is not likely to have as great of an impact as a consistent program with regular mailings on a set schedule.

CEI recommends a long-term continuing education program that incorporates a combination of press releases, flyers, brochures, newsletters and/or other mailings. We suggest beginning with creating some positive public relations for the LAWPC by highlighting upcoming projects such as the proposed trail network that will be available for residents to use.

LAWPC should consider developing a quarterly newsletter or brochure for distribution to residents and businesses within the entire watershed. Each issue could focus on a specific watershed protection issue, focusing on the benefits not only to the watershed, but to the residents as well. Some examples include:

- Land acquisition – Highlight the tax benefits to residents associated with buying and protecting lands. Highlight available residential access to protected lands where available. Include trail maps and highlight features of the trails (e.g., views, flora & fauna).

- Septic system maintenance – Highlight the benefits to the homeowner of proper use and regular pumping of septic systems. Proper use of systems would outline chemicals and compounds to avoid putting into the septic system to avoid contaminating their groundwater supply well and to prolong the life of the system. Regular pumping also prolongs the life of the septic system, avoiding the costly expense of replacement (include a dollar amount) before it would otherwise be needed.

- Watershed projects – Keep residents informed of ongoing projects in the watershed, such as shoreline stabilization and vegetation of paved areas. If permanent access ways are incorporated into shoreline stabilization, highlight that LAWPC is providing this access to the lake. Highlight grant funds obtained to complete these projects to help keep water rates down.

- Lawncare and fertilizer use – Outline low or no fertilizer options for lawncare. Provide examples of fields where alternative practices are used (e.g., compost rather than

chemical fertilizers are used to maintain the Boston Red Sox field). Highlight where free compost can be obtained if given away by the Town. Highlight where residents can dispose of leaves and other yard waste. Offer discounted composters.

LAWPC should also work with local organizations within the watershed, such as the Little Wilson Pond Association to establish positive working relationships and to strengthen the watershed protection efforts. These local organizations may be able to assist with localized issues in their areas, such as providing volunteers for cleanup activities or helping to get the word out on watershed protection. A positive relationship between LAWPC and local organizations can strengthen watershed protection activities.

Recommendation: Develop a public outreach program with scheduled mailings, such as quarterly, to residents and businesses within all cities and towns within the watershed. Seasonally time the mailings to have the greatest impact. For example, discuss lawncare in the spring and land acquisition and trail use in the summer. Include a website address and contact information on mailings. Contact local organizations to discuss how LAWPC and organizations can work together.

Actions:

1) Develop information to be included in mailings.
2) Print materials.
3) Quarterly mailings.
4) Contact local organizations within the watershed to discuss opportunities to work together to protect the watershed.

Partners: Auburn Water District and Lewiston Water Division

Budgeted Costs: $5,000 to gather, create, print and mail materials plus staff time

Annual Costs: $5,000 for printing and distribution of materials plus staff time

10C. School Education Program

The education of children can go a long way to protect the environment as they gain an understanding of the environment and how it works at a young age and also bring materials home to their parents and discuss it with them. The *Project Wet* program was developed to fit into a school curriculum and teaches kids to understand and improve local water quality. It has been successful in other areas of Maine and the country.

Recommendation: Develop a school education program, such as *Project Wet* adapting it to the Lake Auburn watershed.

Actions:

1) Coordinate with Maine DEP Project Wet staff and local schools to bring information on the Lake Auburn watershed into the school curriculum.

Partners: Auburn Water District, Lewiston Water Division, Maine DEP Project Wet staff, local schools

Budgeted Costs: Staff time for LAWPC to coordinate directly with Maine DEP Project Wet Coordinator.

Annual Costs: $0

10D. Agricultural Education Program

Existing and potential future agricultural uses within the watershed can be a significant source of phosphorus as discussed above. These loads can come from the overuse of fertilizers, soil erosion due to planting activities, improper storing or use of animal wastes and grazing of animals near tributaries to the Lake. There are several agricultural best management practices that farmers can use to minimize adverse water quality impacts. These techniques may involve a combination of erosion controls, proper storage techniques, controlled fertilizer applications, buffers, etc. Practices such as these can reduce the phosphorus load from hay/field and crop activities by 54% (combined nutrient management and cropland protection techniques).

As discussed in Section 4.0, agricultural property owners are regulated by the Department of Agriculture, Food and Rural Resources and receive assistance from the Maine Soil and Water Conservation Districts (SWCD) and the United States Department of Agriculture Natural Resources Conservation Service (NRCS), which also assist with the preparation of Management Plans to control runoff and pollutant loads from these properties. LAWPC has also worked with agricultural property owners to better understand the chemicals being applied within the watershed and to offer assistance where needed. However, some property owners are reluctant to disclose this information not fully understanding the LAWPC's position.

Coordination with the above programs and targeted outreach efforts to the agricultural property owners within the watershed will help to ensure that each property has and follows a Management Plan to control pollutant loads. Working with local code enforcement officers from each town within the watershed may also help LAWPC to obtain needed information on farming practices where reluctance has been encountered in the past. The use of positive reinforcement, such as annual awards or recognition for businesses with good environmental practices can help build a positive relationship between LAWPC and the agricultural community, in turn creating a working relationship.

LAWPC should target farms along tributaries to the Lake for direct contact and offer assistance to these farmers to ensure they are incorporating best management practices in their operations. LAWPC currently maintains an inventory of agricultural land uses within the watershed. These properties and their practices should be included on a map and cross-referenced with the locations of tributaries to the Lake to develop a list of the agricultural properties of greatest concern for followup actions.

Recommendation: Work with the Department of Agriculture, Food and Rural Resources, SWCD and NRCS to ensure that all agricultural property owners have and follow Management Plans. Work with local Code Enforcement Officers in each watershed Town to obtain information on the use and application of chemicals at specific properties within the watershed. Work with these programs to develop a public education program that incorporates watershed specific information into existing available public education materials and provide this

information to agricultural property owners. Identify agricultural properties on tributaries to the Lake and work directly with these property owners to ensure that best management practices are used to protect the Lake.

Actions:

1) Update list of agricultural property owners in the watershed and locate on a map.
2) Identify those properties along tributaries to Lake Auburn.
3) Work directly with property owners along tributaries to ensure best management practices are used.
4) Work with local Town Code Enforcement Officers in the watershed to obtain information on the use and application of chemicals at specific properties within the watershed.
5) Contact local programs to determine who has or needs a Management Plan.
6) Work with local programs to ensure properties have a Management Plan.
7) Develop education materials (e.g., brochures, fact sheets) outlining the importance of watershed protection for maintaining the filtration waiver and how agricultural property owners can limit loads from their properties.

Partners: Department of Agriculture, Food and Rural Resources, SWCD, NRCS, Turner Code Enforcement Officer, Minot Code Enforcement Officer, Hebron Code Enforcement Officer, Buckfield Code Enforcement Officer

Budgeted Costs: Staff time to generate lists and meet with property owners and local agencies. Material costs included under 10B.

Annual Costs: Staff time

#11 Continue Key Parcel Land Acquisition and Conservation Efforts of Environmentally Sensitive Land Areas

The protection of key parcels within the watershed has been a focus of the LAWPC, Auburn Water District and Lewiston Water Division since the early 1920s. Since development is the greatest contributor of pollution to the lake, protection of lands is the best means to minimize pollution loads to the lake and maintain the filtration waiver. The LAWPCs current prioritization scheme for land acquisition focuses first on lands with frontage on Lake Auburn and the major tributaries to the lake (Townsend Brook and The Basin) followed by land within 250 feet of the shoreline and those parcels with current or future potentially harmful land uses.

Other benefits of land preservation include increased recreational opportunities and some studies[2] have shown that the protection of open space has benefits from a community's economic or fiscal perspective. The studies compare the tax revenues generated by developed land uses versus the public services costs (e.g., police and fire protection, road maintenance, local government and schools) associated with those land uses and shows that the costs of

[2] Washtenaw Land Trust. *Community Economic Benefits of Land Protection.* Retrieved September 2, 2009 from the World Wide Web: http://www.washtenawlandtrust.org/economic.htm

services often exceeds the revenues, therefore providing more economic incentive for protecting lands.

Recommendation: Continue key parcel land acquisition and conservation efforts for environmentally sensitive land areas within the watershed.

Actions:

1) Continue with current land acquisition policy within the watershed.
2) Promote selected access of protected lands for recreational purposes.
3) Include information on the water quality, environmental and economic benefits or protecting land.

Partners: Auburn Water District, Lewiston Water Division, City Councils

Budgeted Costs: see Annual Costs

Annual Costs: $250,000 currently included in annual budget

#12 Develop Trail Networks on LAWPC Properties

The Auburn Water District, Lewiston Water Division and LAWPC have acquired a significant amount of property within the Lake Auburn Watershed under its Land Acquisition Policy in an effort to protect the watershed and water quality of the lake and to maintain the existing filtration waiver. Recently, the LAWPC has considered enhancing recreational opportunities along the lake by providing access to the citizens of the area on these lands. One such project currently under consideration is the Bike and Pedestrian Master Plan, Southern Link, which is evaluating the development of a Bike and Pedestrian facility along the southern portion of the Lake Auburn Watershed, beginning at the Boat Launch along Route 4 finding its way along outer Turner Street past the Central Maine Community College to Gracelawn road, along Gracelawn past St. Dominic's Regional High School and the old city landfill to a point terminating at the Berry property directly across from park Avenue. The project is currently in the preliminary planning stages.

Allowing public access to protected lands benefits the public, while increasing public support of watershed protection. Providing public access can also help the LAWPC police and monitor the land for improper uses and problems.

Recommendation: LAWPC should pursue the Bike and Pedestrian Master Plan, Southern Link further and evaluate trail options for other select properties. Develop a set of general specifications for areas of concern such as tributary crossings. A set of specifications would ensure the inclusion of Best Management Practices (BMPs) where trails cross tributaries to the Lake to prevent the introduction of additional pollutant loads into the Lake from trail access (e.g., sediment loads from disturbed paths). This is particularly important considering that trail design may be performed by landscape architects or other professionals that may not be aware of the environmental impacts and measures to control them.

Actions:

1) Finalize layout and plans for Southern Link trail network and pursue funding for construction.
2) Review other LAWPC lands in the watershed and assess suitability for trail development based on factors such as: potential impact to water quality; linkage to other trail networks in the watershed; ease of accessibility; scenic value, etc.
3) Prioritize lands for trail development and prepare a plan identifying lands suitable for access and those that are not.
4) Develop general specifications for general areas of concern such as tributary crossings.

Partners: Auburn Water District, Lewiston Water Division, Androscoggin Transportation Resource Center

Budgeted Costs: $400,000 to design and build the Bike and Pedestrian Master Plan, Southern Link. Costs obtained from Long Range Facilities Plan.[3] AWD, LWD, LAWPC share budgeted at $30,000 to help secure funding (e.g., match), with remainder anticipated to be covered by outside funding sources.

Annual Costs: Staff time to maintain trails.

#13 Continue with Invasive Species Controls

Invasive plants displace the native plant populations that support wildlife habitat and prevent erosion. They also hinder boating and increase the rate of lake filling and internal recycling of nutrients through their die off cycles.

The LAWPC has an active invasive species control program to prevent the growth and spread of invasive plant species, with a focus on variable leaf milfoil (VLM) in the lake. Past control practices are summarized in Table 5-3.

The success rate of the program was found to vary between locations. The Basin is already infested, making benthic barriers ineffective for this large area, but they were effective in smaller areas of infestation. Efforts were made to control VLM in wetlands adjacent to Lake Auburn proper and North Auburn Cove, with no physical removal in the lake itself in these areas. Annual surveys have helped identify new areas of VLM, allowing for rapid response and minimizing the spread of VLM outside of the established areas.

The approach to date has focused on the prevention of VLM from spreading in the lake. Once VLM spreads to a large area removal becomes more difficult and expensive, and may require full harvesting with mechanical equipment and/or the application of herbicides to effectively control, both of which have negative impacts to water quality and habitat. Thus, continuation of prevention measures is recommended in accordance with the existing actions taken.

[3] Androscoggin Transportation Resource Center. Bridging the Gaps: A Long Range Facilities plan for Bicycling and Walking in the Lewiston-Auburn Area. June 2002.

Table 5-3. Past Invasive Species Control Practices								
	2001	2002	2003	2004	2005	2006	2007	2008
Whole-lake macrophyte survey	X	X	X	X	X	X	X	X
Signage around lake and at boat launches		X	X	X	X	X	X	X
Inspection of boats at boat launches		X	X	X	X	X	X	X
Deployment of marker buoys denoting restricted areas		X	X	X	X	X	X	X
Hand pulling VLM in Basin			X	X	Too demanding & ineffective to continue			
Benthic barriers				X	X	X	X	X
Hand pulling in wetland areas					X		X	X
Total Cost			$1,645	$3,512	$5,256	$4,868	$15,045	$14,002

Recommendation: Continue with the current invasive plant control program, continually assessing the effectiveness of the program and adjusting accordingly.

Actions:

1) Obtain State grant funding for invasive plant control.
2) Implement control strategies annually and assess effectiveness of controls.
3) Adjust program in accordance with findings of annual assessments of effectiveness.

Partners: Auburn Water District, Lewiston Water Division

Budgeted Costs: see Annual Costs

Annual Costs: $15,000 (included in existing annual budget) for physical weed control activities and inspections

#14 Continue Gull Management

Lake Auburn experienced an increase in bacteria levels in 2004 that put the filtration waiver at risk of being revoked. The increase in bacteria was linked to the presence of large flocks of gulls on the lake. As a result, LAWP contacted the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) to perform gull management activities on the lake, which began in the fall of 2005. Since then gull management techniques have been employed annually by WS, resulting in lowered bacteria levels that have remained within EPA compliance standards for keeping the filtration waiver.

Recommendation: Continue with the gull management program as recommended by WS to minimize gull populations and associated bacteria.

Actions:

1) Coordinate the gull management program with WS.
2) Continue to monitor the results of the management program and adjust as needed based on the recommendations of WS.

Partners: Auburn Water District, Lewiston Water Division, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

Budgeted Costs: see Annual Costs

Annual Operating Costs: $140,000 (included in existing annual utility budget)

#15 Continue Monitoring Program

The LAWPC has been collecting water quality information from the lake since the late 1970s, beginning with temperature and dissolved oxygen levels at the deep spot in the lake. The monitoring program has evolved over the years to meet the requirements of the Safe Drinking Water Act and Amendments and to monitor trends of the general water chemistry of the lake. A copy of the 2009 raw water testing program is included in Appendix G.

The existing monitoring program is fairly extensive, including testing of the two major inlets to the lake, The Basin and Townsend Brook, and several areas within the lake, including the deep spot of the lake. Raw water samples were also tested for emerging contaminants in 2008 to determine whether they were present, even though they are not regulated at this time. None were detected. Some suggested modifications to the existing program are proposed to maximize the collection of the best data to assess the health of the lake and watershed and to include future sampling of emerging contaminants.

Recommendation: Continue the monitoring program with the following suggested changes:

1) Collect monthly samples for phosphorus analysis at Site #8 DEEP HOLE between April and December. Samples should be collected from the epilimnion (1 meter below surface), metalimnion (within the thermocline) and hypolimnion (1 meter from the bottom) layers.
2) Collect samples for emerging contaminants including estrogens and other hormones, pharmaceutically active compounds and phenolic endocrine disrupting chemicals once every three years from the finished water.
3) Estimate flow data for tributaries on the date the data is collected. This can be conducted through the installation of staff gages and development of stage-discharge curves and provides a better understanding of the data (e.g., are concentrations lower with greater flows indicating dilution, allows for estimation of actual flow loads versus concentrations).
4) Consider creating a searchable database of water quality data that includes all of the data collected to date by location and date, allowing it to be searched by any given parameters (e.g., date, water quality parameter, location, weather conditions, etc.).

Actions:

1) Revise monitoring program beginning in 2010 to include above recommendations.

Partners: Auburn Water District, Lewiston Water Division

Budgeted Costs: $18,000 to install staff gages at six locations and develop stage-discharge curves
$10,000 to create searchable database

Annual Costs: $62,000 to continue existing monitoring program plus $650 for additional recommended phosphorus sampling at Site #8 DEEP HOLE and $1,500 every three years for sampling of emerging contaminants. Assumes additional samples can be collected within the existing labor budget.

Table 5-1: Lake Auburn 10-Year Watershed Management Program Capital Improvement Program Budget															
	Total Annual Costs[1]										Total Capital and Average Annual Costs				
Option	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Capital Cost**	**Annual Costs**	**Lbs /Yr Removed**	**Lbs Removed Over 10 Years**	**$/lb (10-Yr)**
1. Promote the Use of Low Impact Development (LID) Techniques for Development and Redevelopment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0	0	$0
2. Amend Zoning Ordinance to Strengthen Wastewater Disposal Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	154	1,539	$0
a. Increase vertical separation to restrictive layer in sandy soils from 24" to 36"											$ -	$ -			
b. Require a minimum 300 foot horizontal setback from all waterbodies within the watershed											$ -	$ -	154	1,540	
c. Require periodic inspection of existing septic systems											$ -	$ -			
d. Add system maintenance requirements to the ordinance											$ -	$ -			
e. Require a reserve area for a replacement disposal field											$ -	$ -			
f. Require septic systems be located on the same lot as the building it serves											$ -	$ -			
g. Explore opportunities to provide needs-based financial support for system upgrades/replacement											$ -	$ -			
3. Update Phosphorus Control Ordinance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	13	13	$0
4. Amend Ordinance to Prohibit Certain Land Uses Within the Lake Auburn Watershed Overlay District	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		
5. Work with the City DPW to Address Drainage Issues Within the Watershed	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0		
6. Set Aside Funds for Maintenance of Watershed Lands	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ -	$ 10,000	0		
7. Address Direct Stormwater Discharges on Route 4 and Within Other Areas of the Watershed[2]	$ -	$ -	$ -	$ -	$ -	$ -	$ 78,800	$ 56,900	$ 56,900	$ 11,400	$ 204,000	$ -	24	241	$848

Table 5-1: Lake Auburn 10-Year Watershed Management Program Capital Improvement Program Budget															
	Total Annual Costs[1]										Total Capital and Average Annual Costs				
Option	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Capital Cost**	**Annual Costs**	**Lbs /Yr Removed**	**Lbs Removed Over 10 Years**	**$/lb (10-Yr)**
Outfall 1 - Discharges to east side of Route 4 - No Action											$ -				
Outfall 2 - Outfall capped and redirected to east side Route 4 - No Action											$ -				
Outfall 3 - Deep sump catch basin										$ 5,700	$ 5,700				
Outfall 4 - Proprietary treatment device							$ 78,800				$ 78,800				
Outfall 5 - Proprietary treatment device								$ 56,900			$ 56,900				
Outfall 6 - Deep sump catch basin										$ 5,700	$ 5,700				
Outfall 7 - Proprietary treatment device									$ 56,900		$ 56,900				
8. Supplement Erosion Control Strategies Along Lake Shore Drive and Other Locations Along the	$ -	$ -	$ 47,500	$ 47,500	$ 47,500	$ 47,500	$ -	$ -	$ -	$ -	$ 190,000	$ -	5	50	$3,764
9. Increase Vegetated Buffers Around the Lake - Replace Route 4 Paved Turnaround with Vegetation	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 30,000	$ -	2	20	$1,529
10. Public Education	$ 6,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 6,000	$ 5,000	722	7,223	$8
a. Enhance the existing website to provide information pertaining to the watershed	$ 1,000										$ 1,000	$ -			
b. Develop a public outreach program	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000			
c. Coordinate with MaineDEP Project Wet staff and local schools											$ -	$ -			
Subtotal a. - c. (targeting residential & businesses)													91		
d. Agricultural Education Program											$ -	$ -	632		
11. Continue Key Parcel Land Acquisition and Conservation Efforts of Environmentally Sensitive	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ -	$ 250,000	0	0	
12. Develop Trail Networks on LAWPC Properties	$ 10,000	$ 10,000	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 30,000	$ -	0	0	
13. Continue with Invasive Species Controls	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ -	$ 15,000	0	0	
14. Continue Gull Management	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ -	$ 140,000	0	0	

Table 5-1: Lake Auburn 10-Year Watershed Management Program Capital Improvement Program Budget															
	Total Annual Costs[1]										Total Capital and Average Annual Costs				
Option	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Capital Cost**	**Annual Costs**	**Lbs /Yr Removed**	**Lbs Removed Over 10 Years**	**$/lb (10-Yr)**
15. Continue Monitoring Program with Proposed Modifications	$80,650	$64,150	$62,650	$72,650	$64,150	$62,650	$62,650	$64,150	$62,650	$62,650	$28,000	$63,100	0	0	
a. Continue existing monitoring program	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ -	$ 62,000			
b. Collect additional monthly phosphorus samples from DEEP hole	$ 650	$ 650	$ 650	$ 650	$ 650	$ 650	$ 650	$ 650	$ 650	$ 650	$ -	$ 650			
c. Collect a sample for analysis of emerging contaminants every three years		$ 1,500			$ 1,500			$ 1,500			$ -	$ 450			
d. Install staff gages and develop stage-discharge curves	$ 18,000										$ 18,000	$0			
e. Create a searchable water quality data database				$ 10,000							$ 10,000	$ -			
Total Cost for All Recommendations	$ 511,650	$ 524,150	$ 535,150	$ 545,150	$ 531,650	$ 530,150	$ 561,450	$ 541,050	$ 539,550	$ 494,050	$ 488,000	$ 483,100	920		
Covered in Existing Budget	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ 467,000	$ -	$ 467,000			
New Costs	**$ 44,650**	**$ 57,150**	**$ 68,150**	**$ 78,150**	**$ 64,650**	**$ 63,150**	**$ 94,450**	**$ 74,050**	**$ 72,550**	**$ 27,050**	**$ 488,000**	**$ 16,100**			
Removal Goal													**1,034**	**10,342**	

[1]All costs are presented in 2010 dollars.

[2]Conceptual design and permitting of all BMPs would be included with the first BMP design, with final design for each specific BMP in following years.

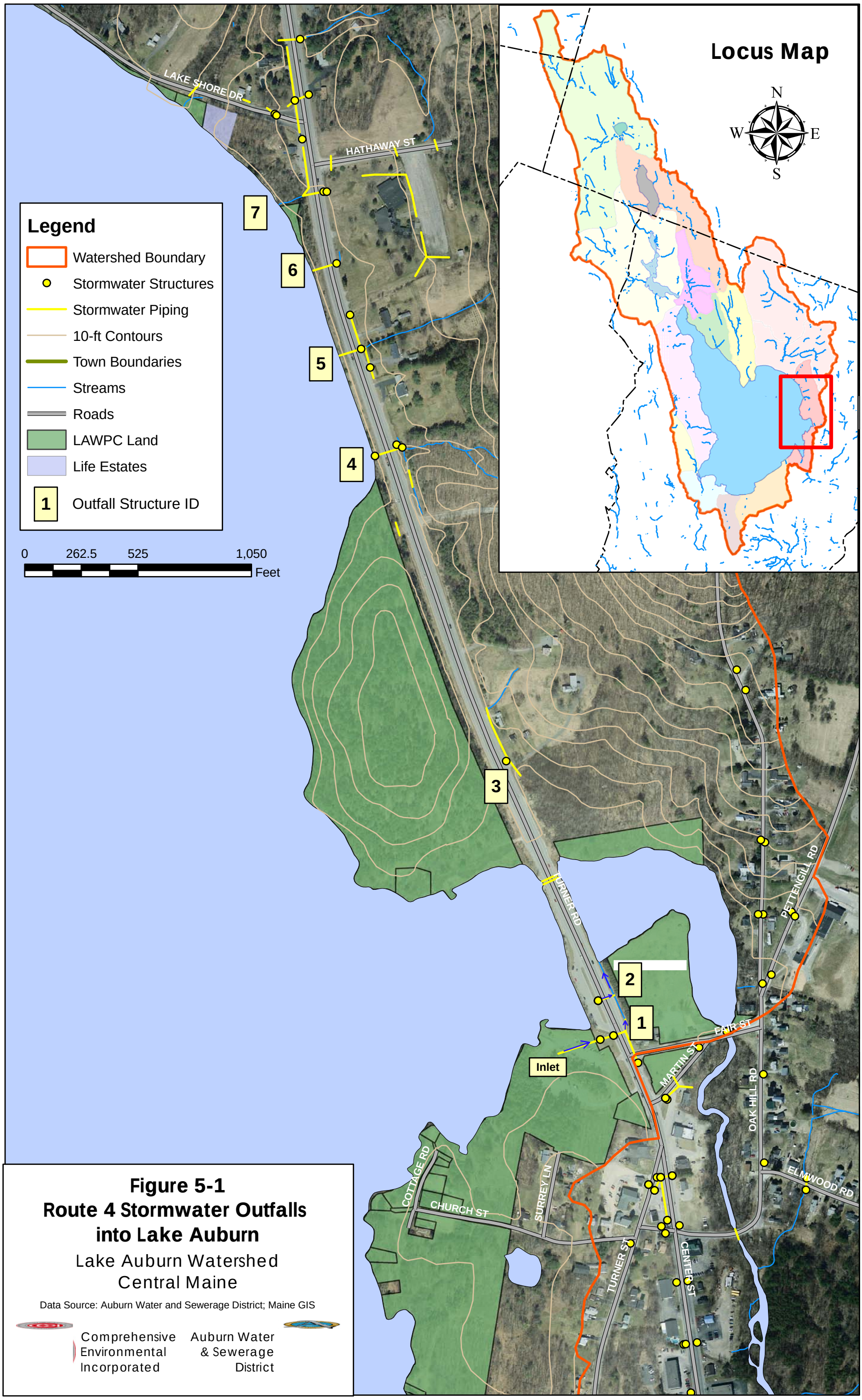
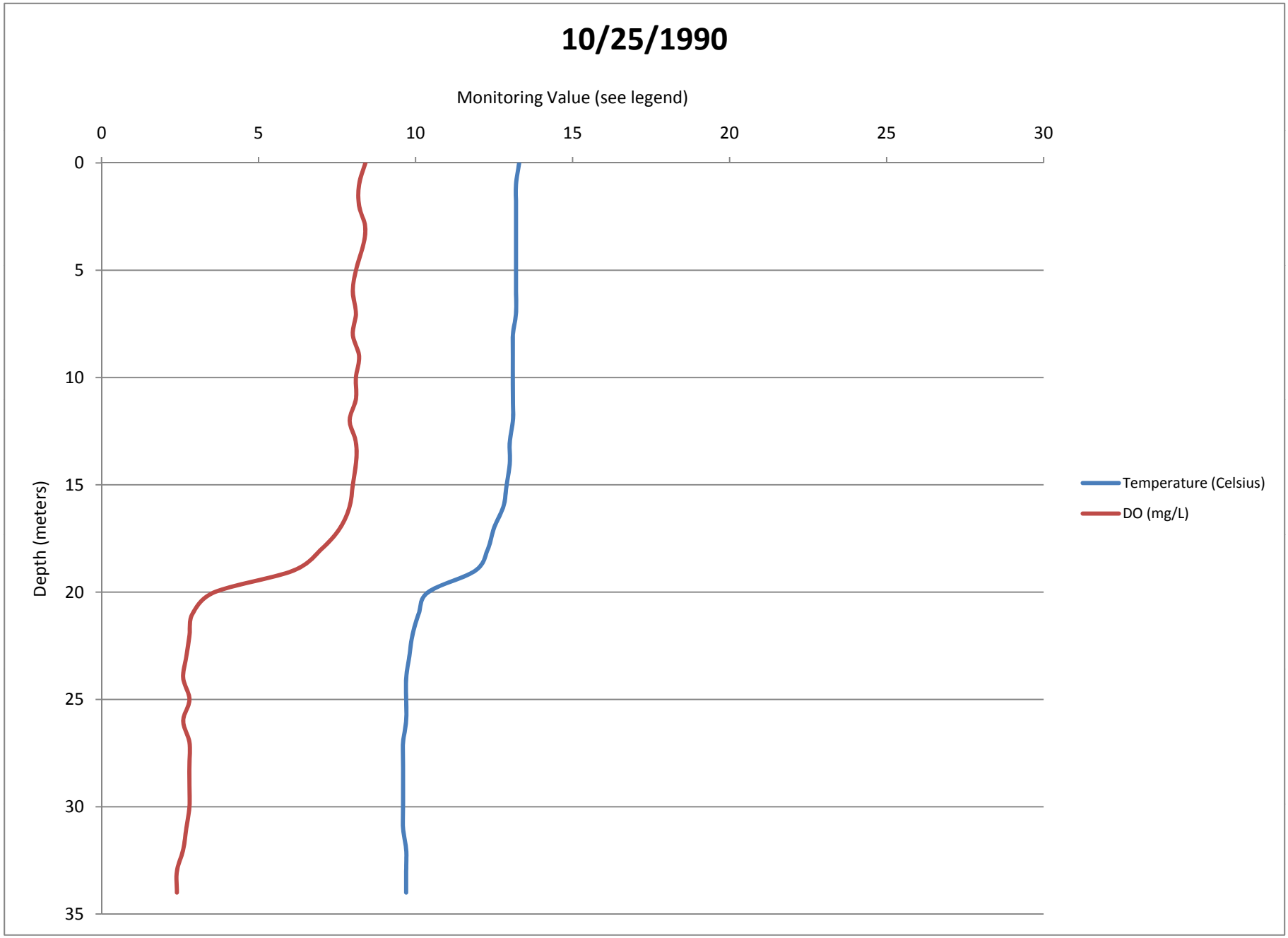
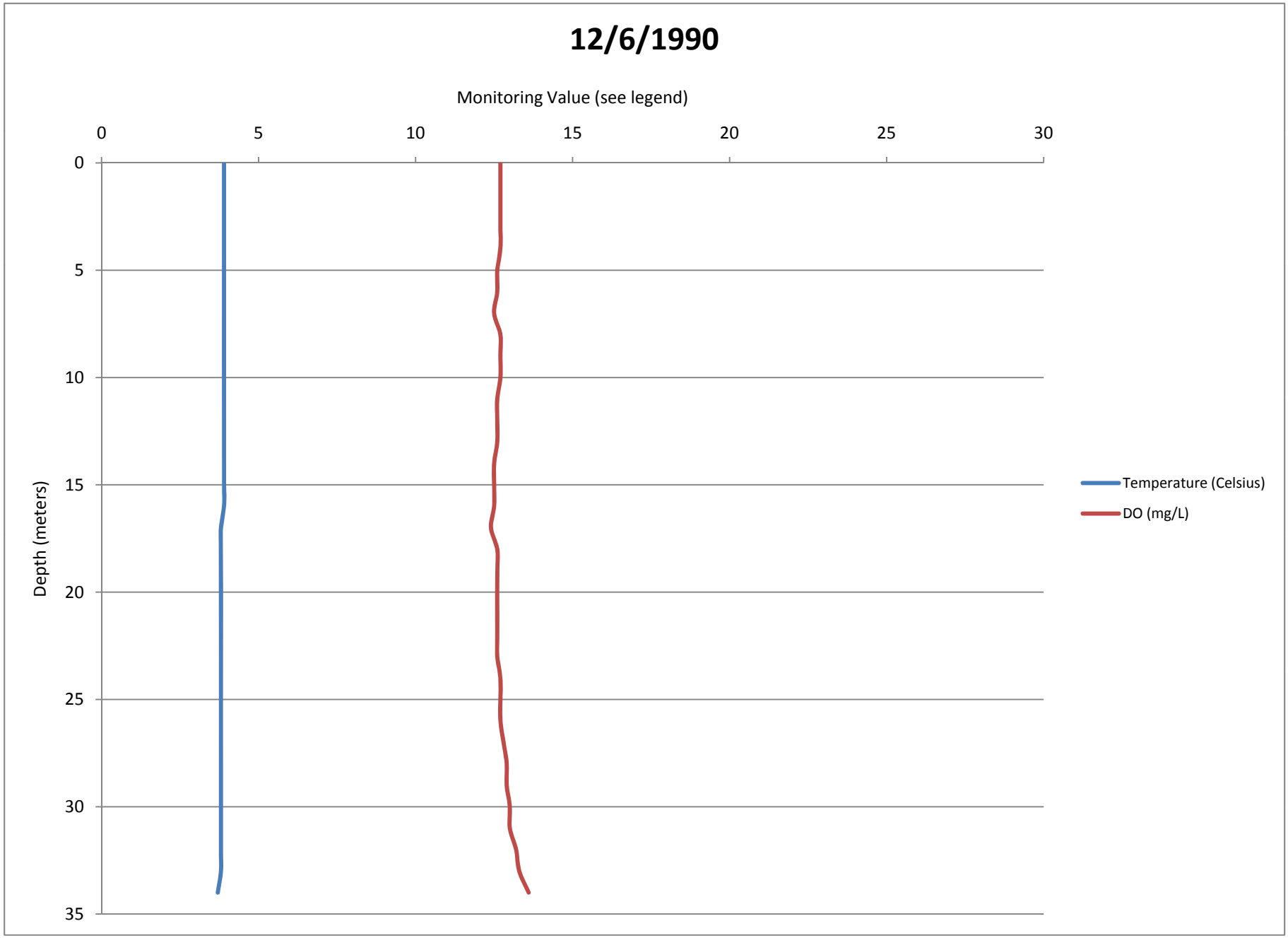


Figure 5-1
Route 4 Stormwater Outfalls into Lake Auburn
Lake Auburn Watershed
Central Maine

Data Source: Auburn Water and Sewerage District; Maine GIS

Appendix A
Temperature and DO Graphs for Lake Auburn


10/25/1990
Monitoring Value (see legend)
0
5
10
15
20
25
30
Depth (meters)
0
5
10
15
20
25
30
35
Temperature (Celsius)
DO (mg/L)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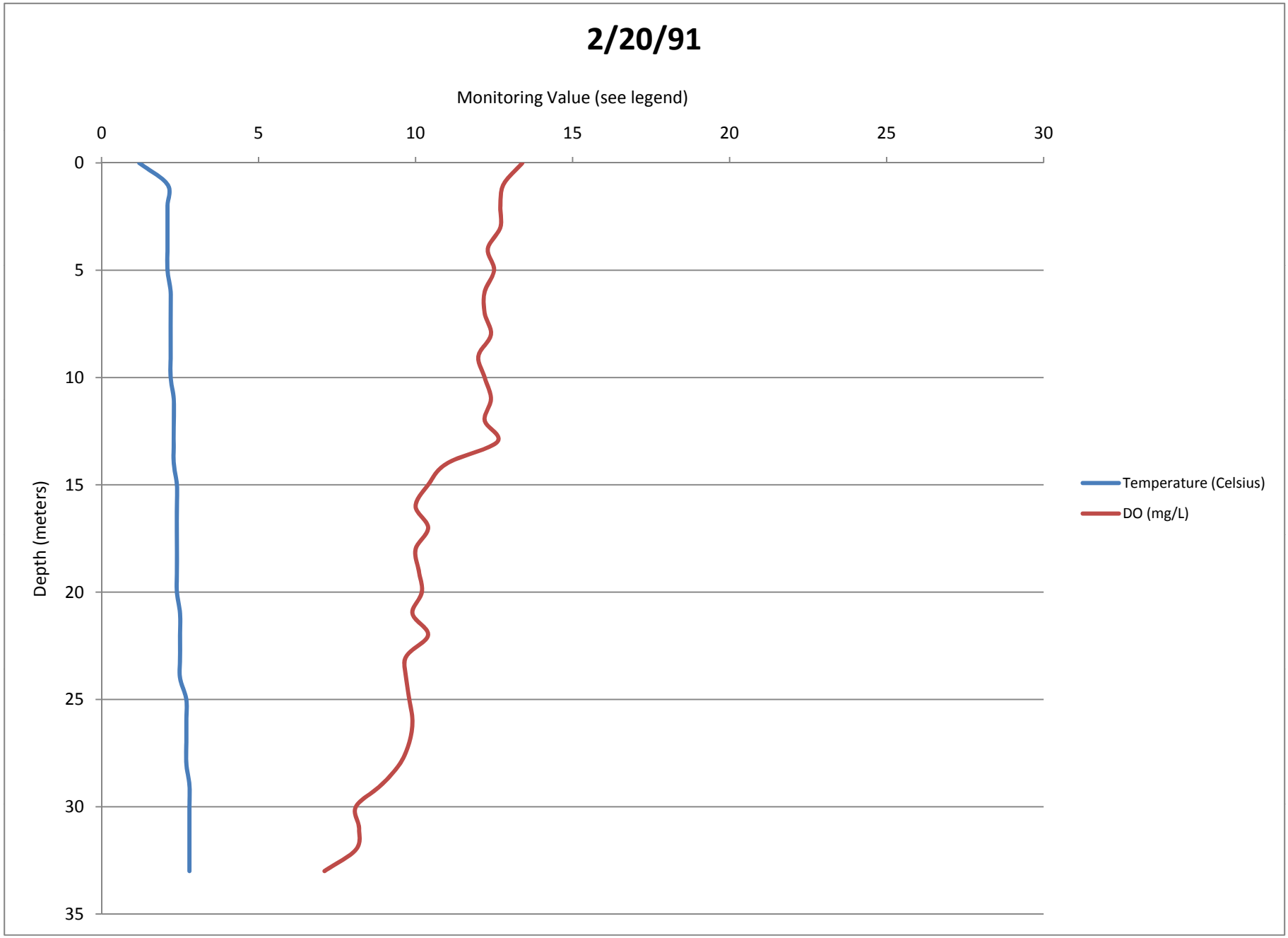
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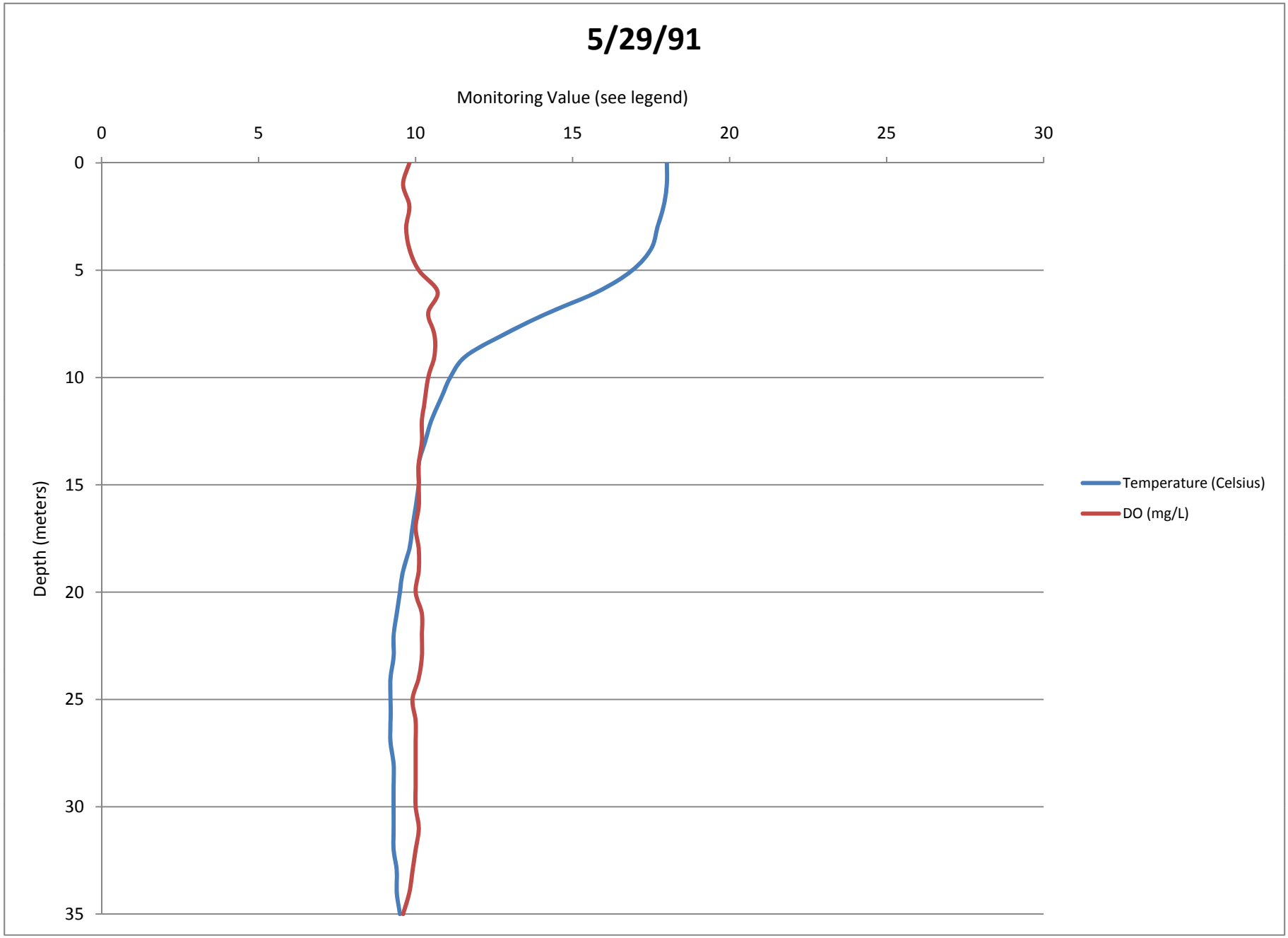
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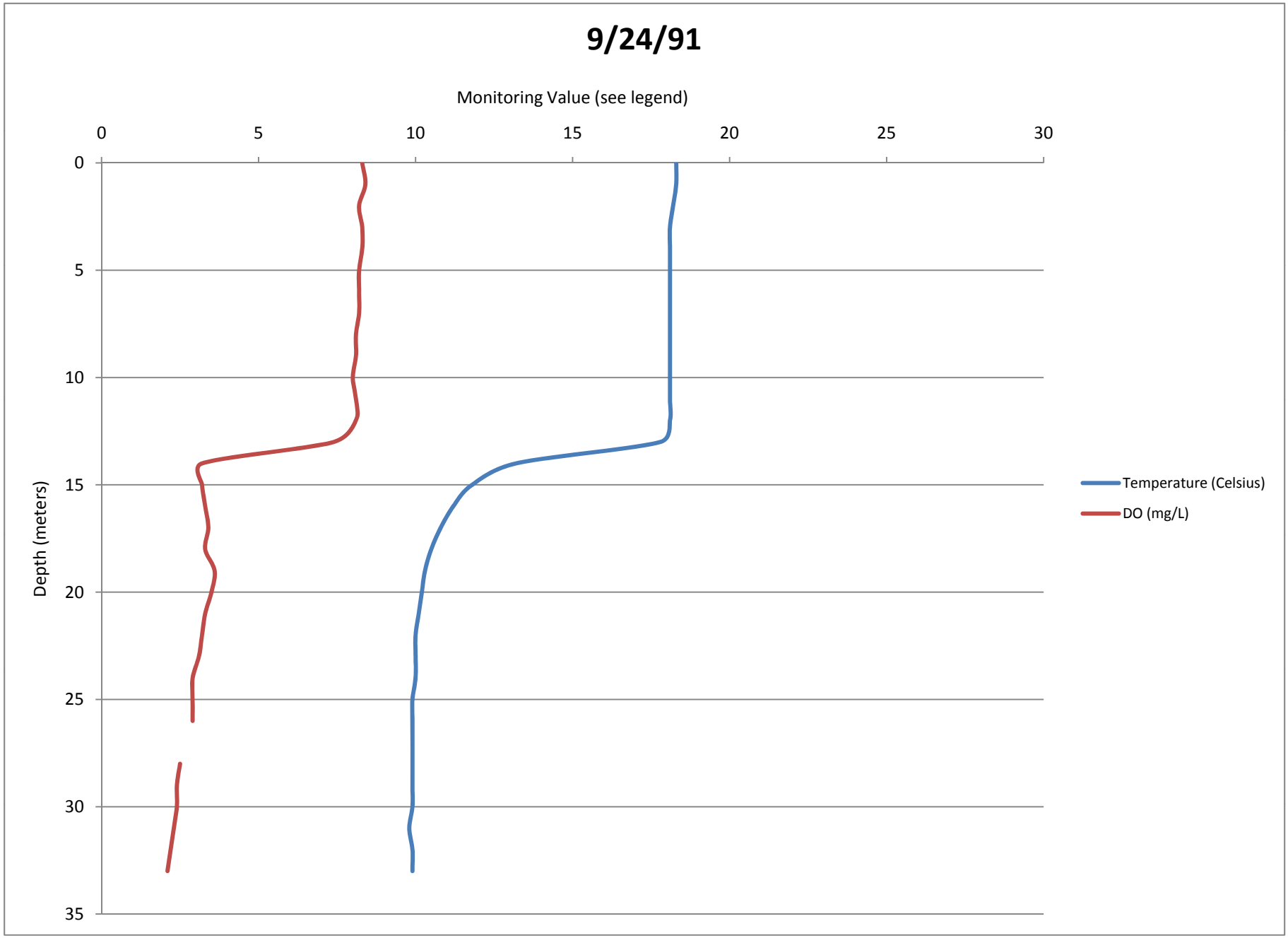
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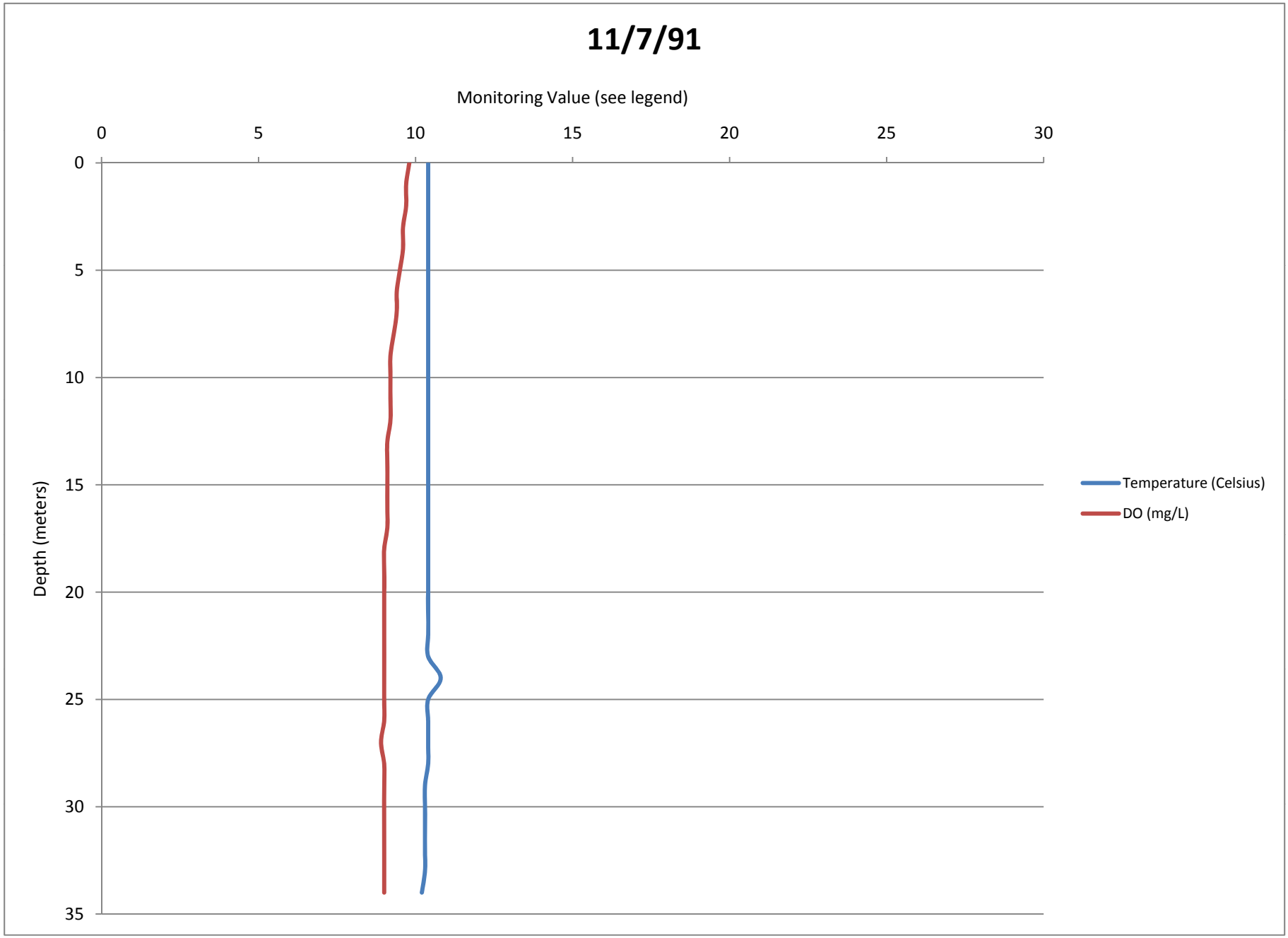
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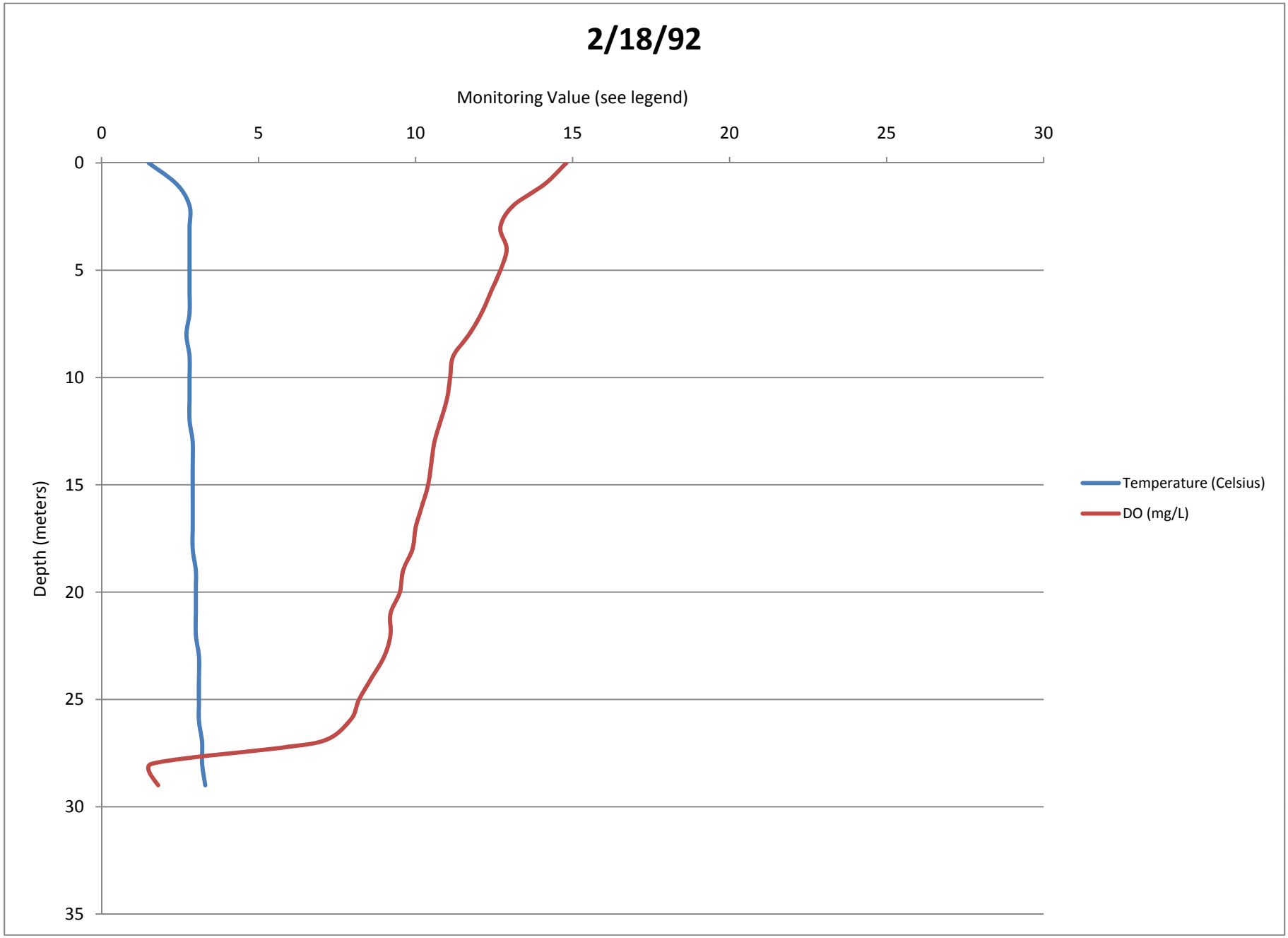
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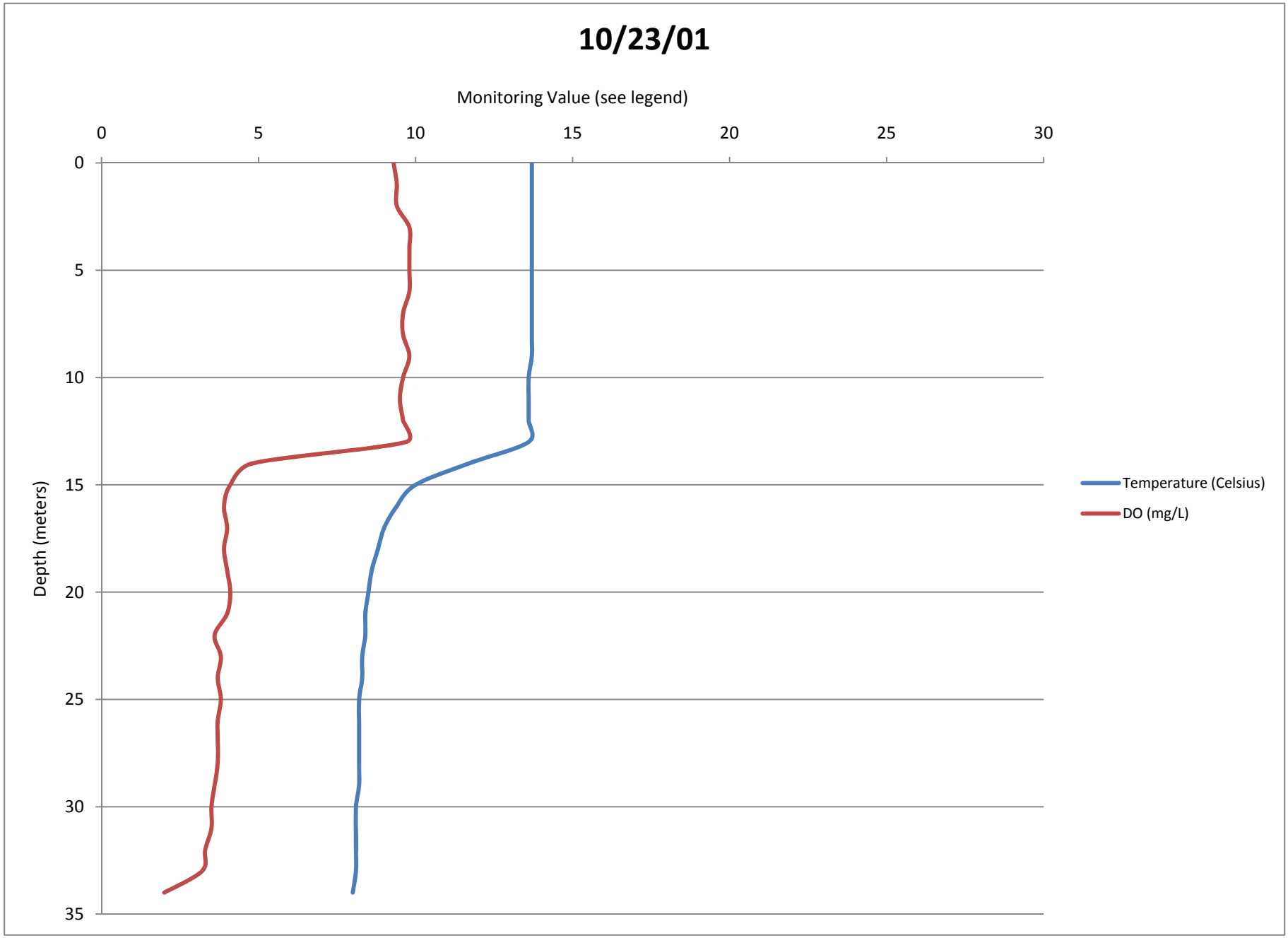
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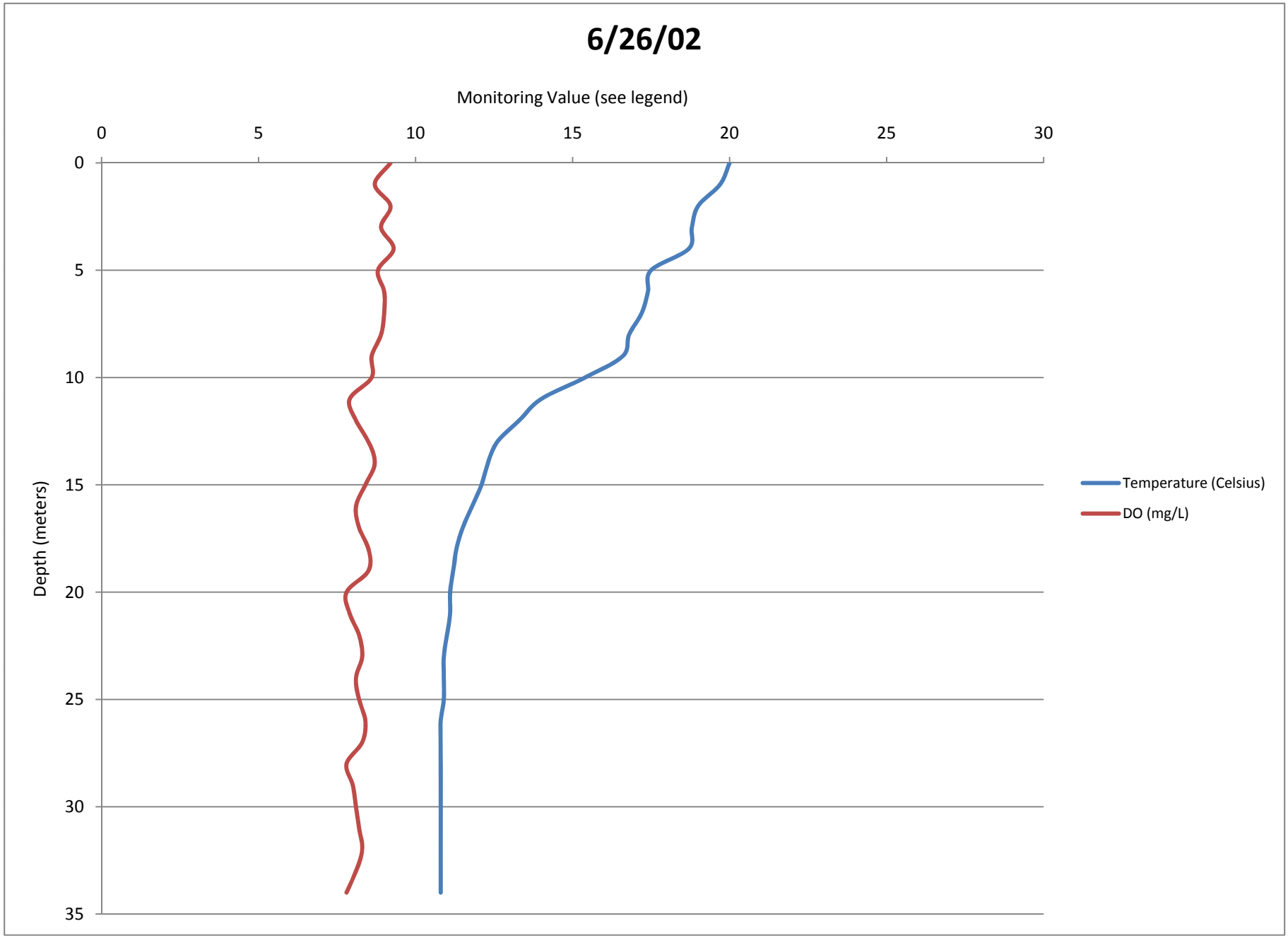
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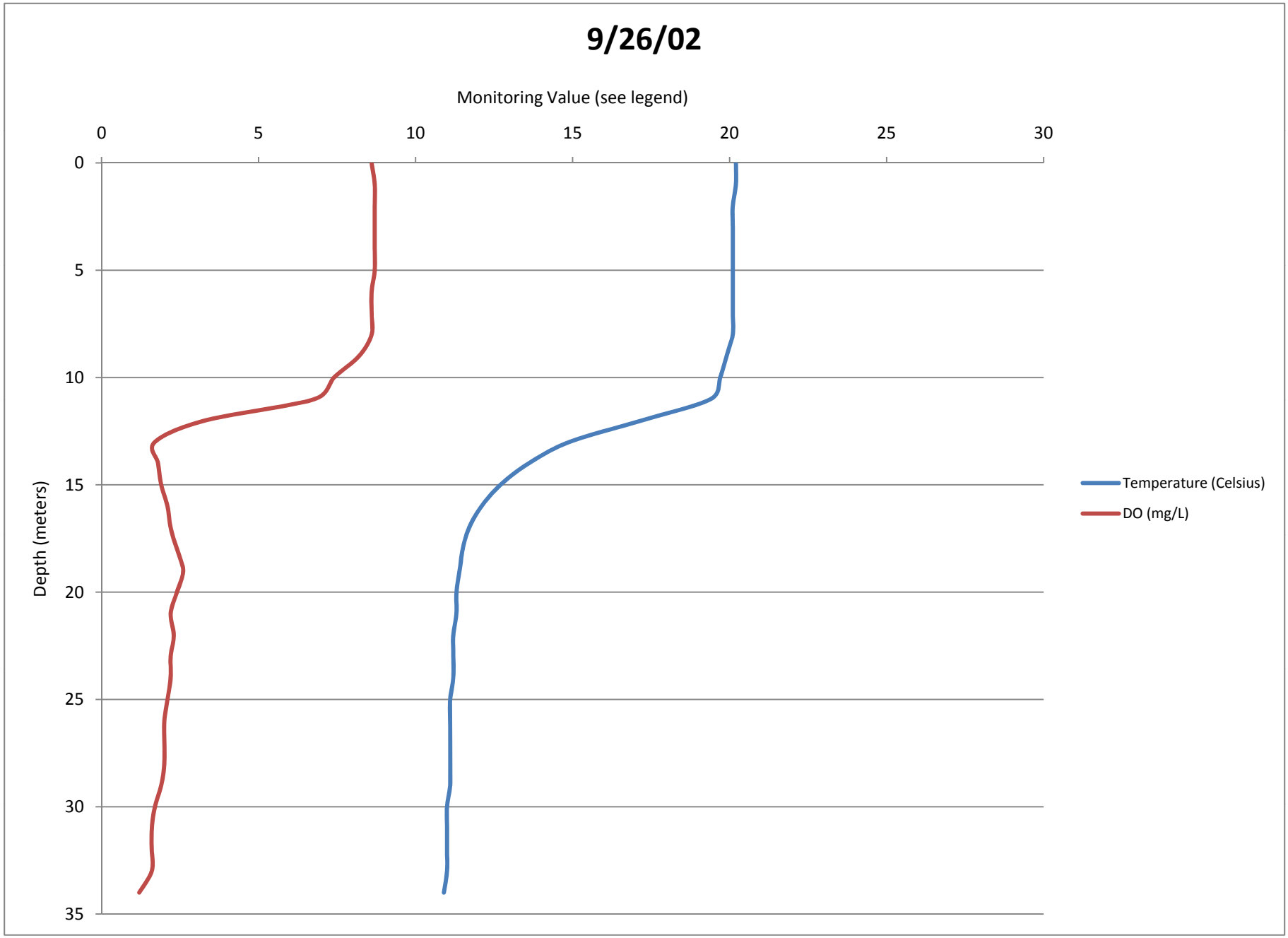
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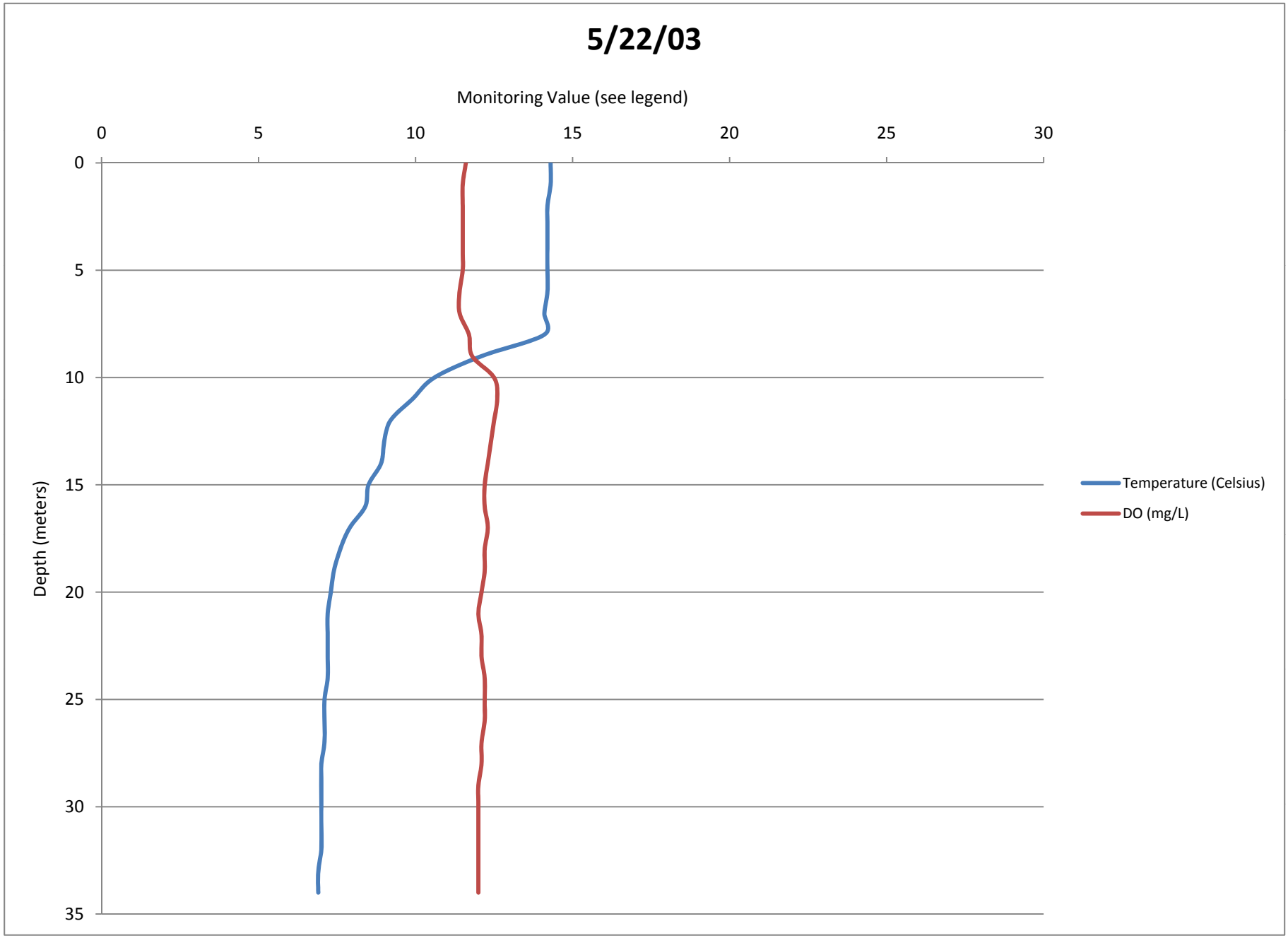
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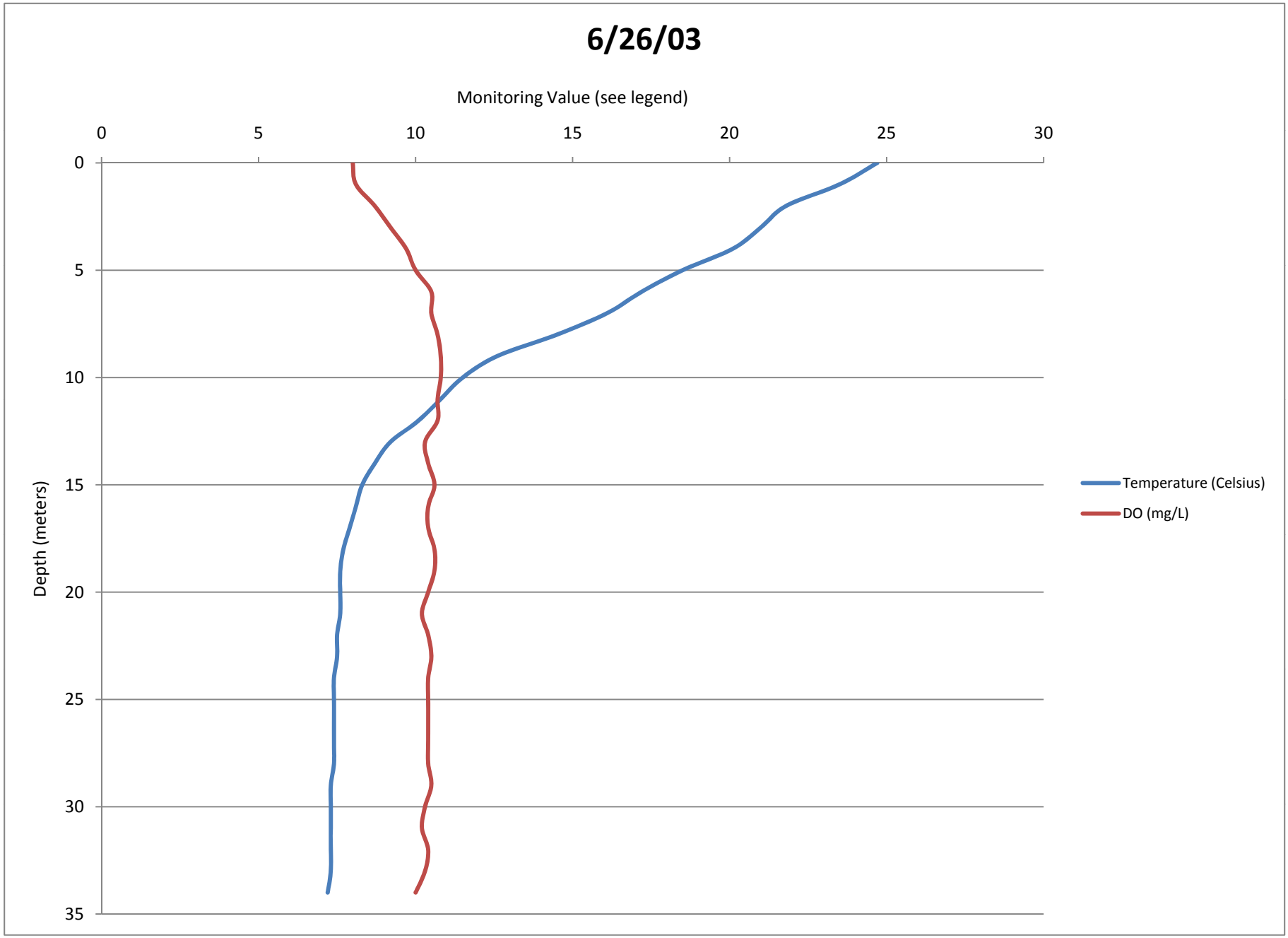
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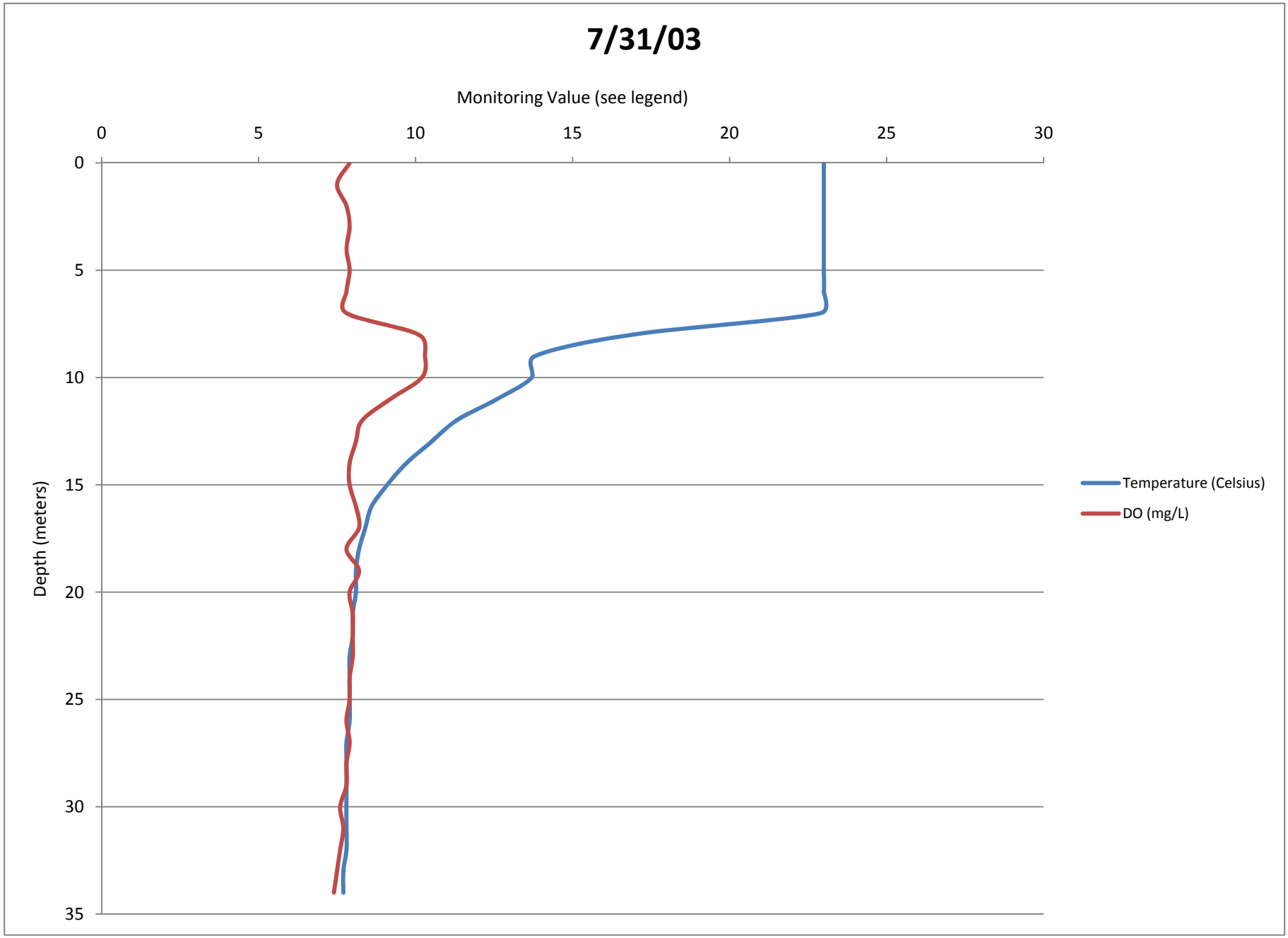
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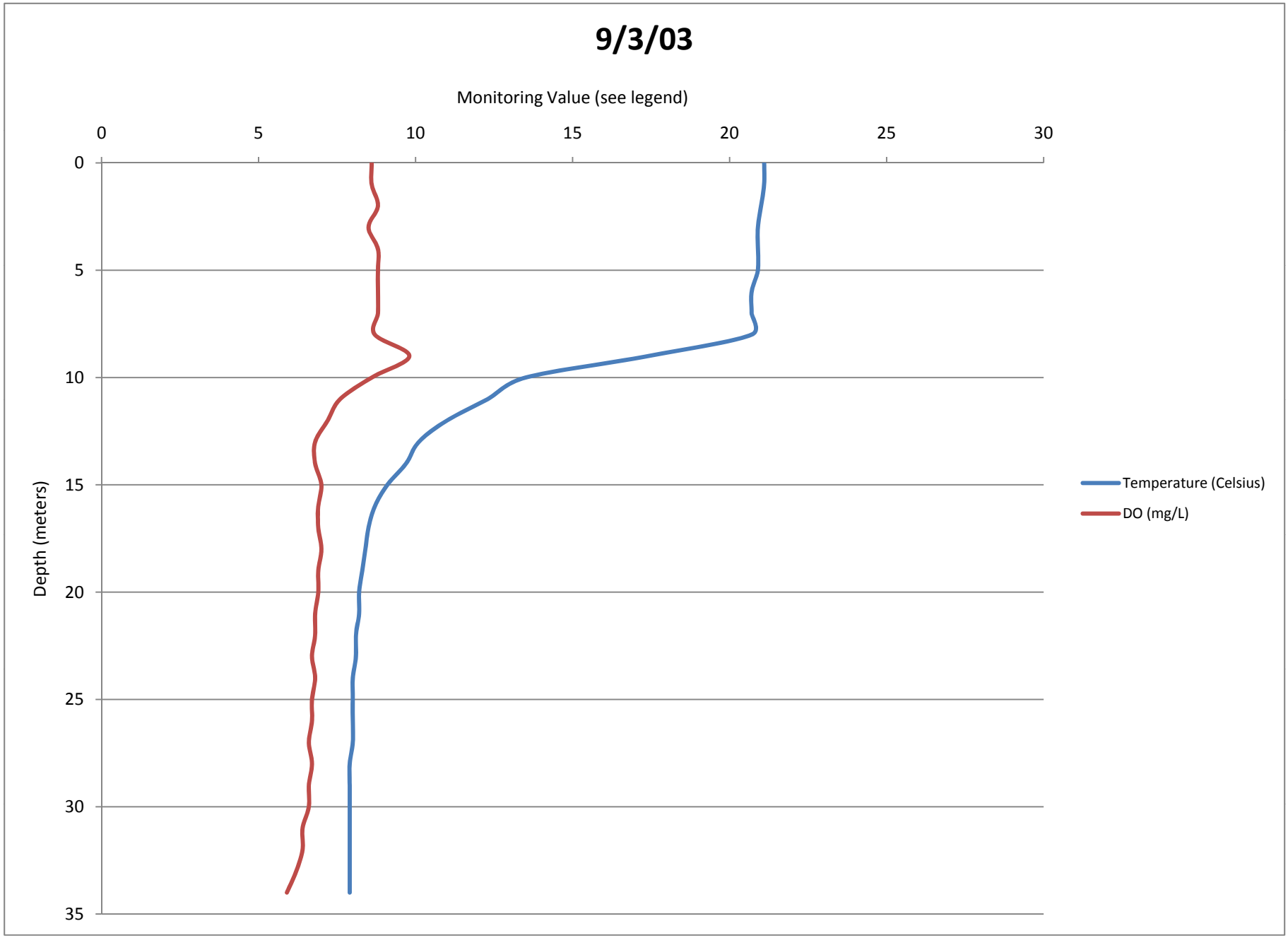
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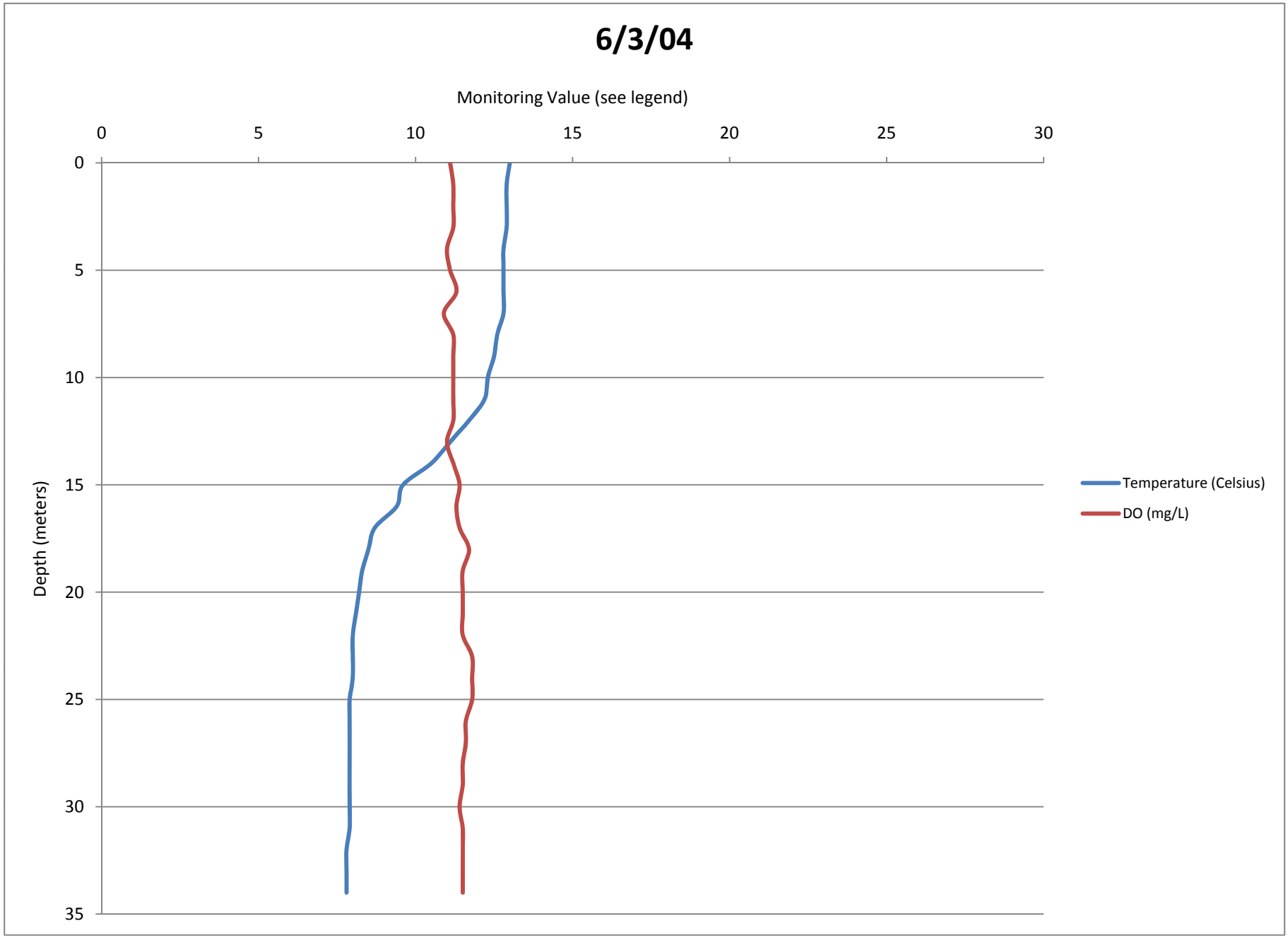
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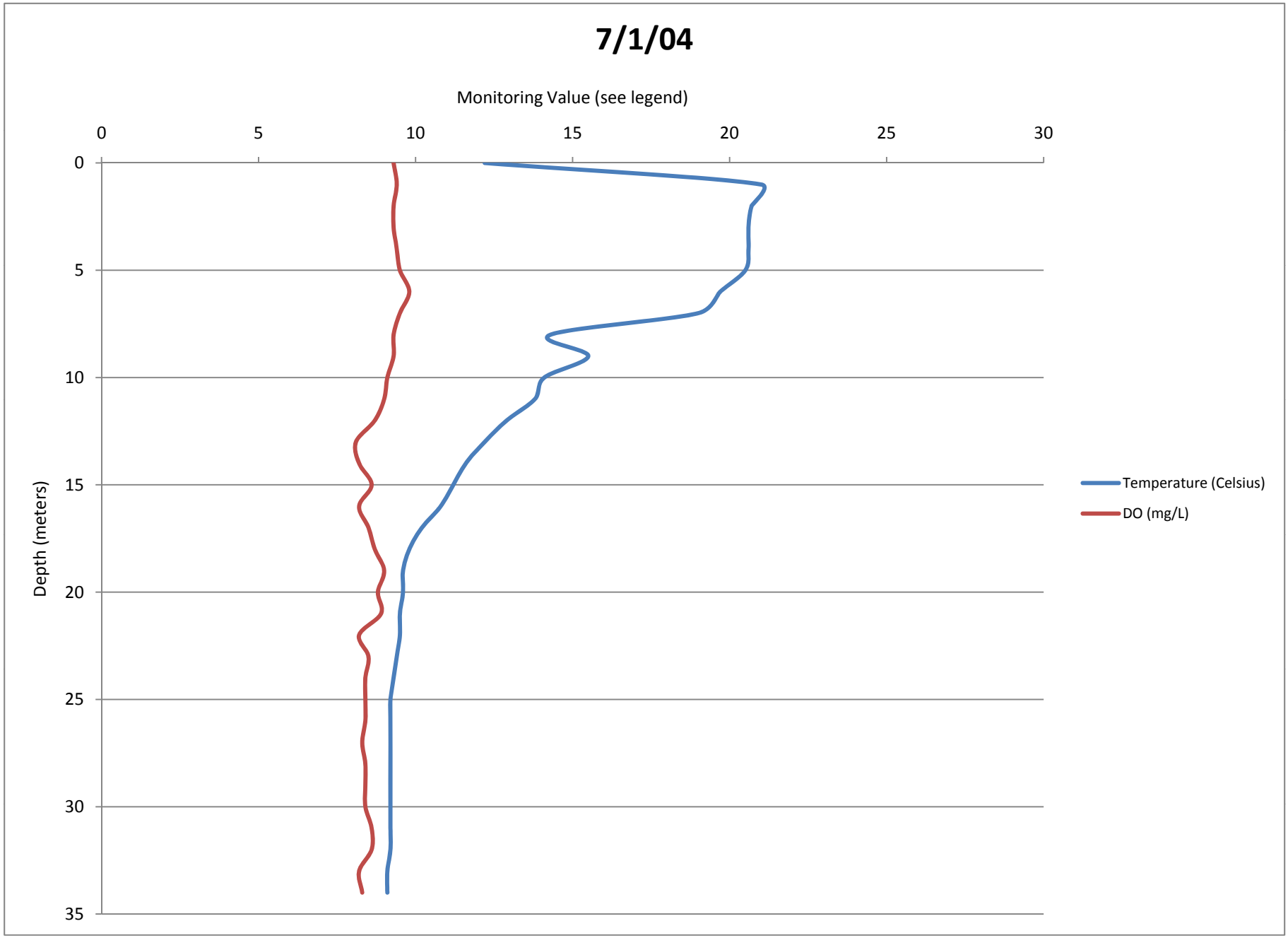
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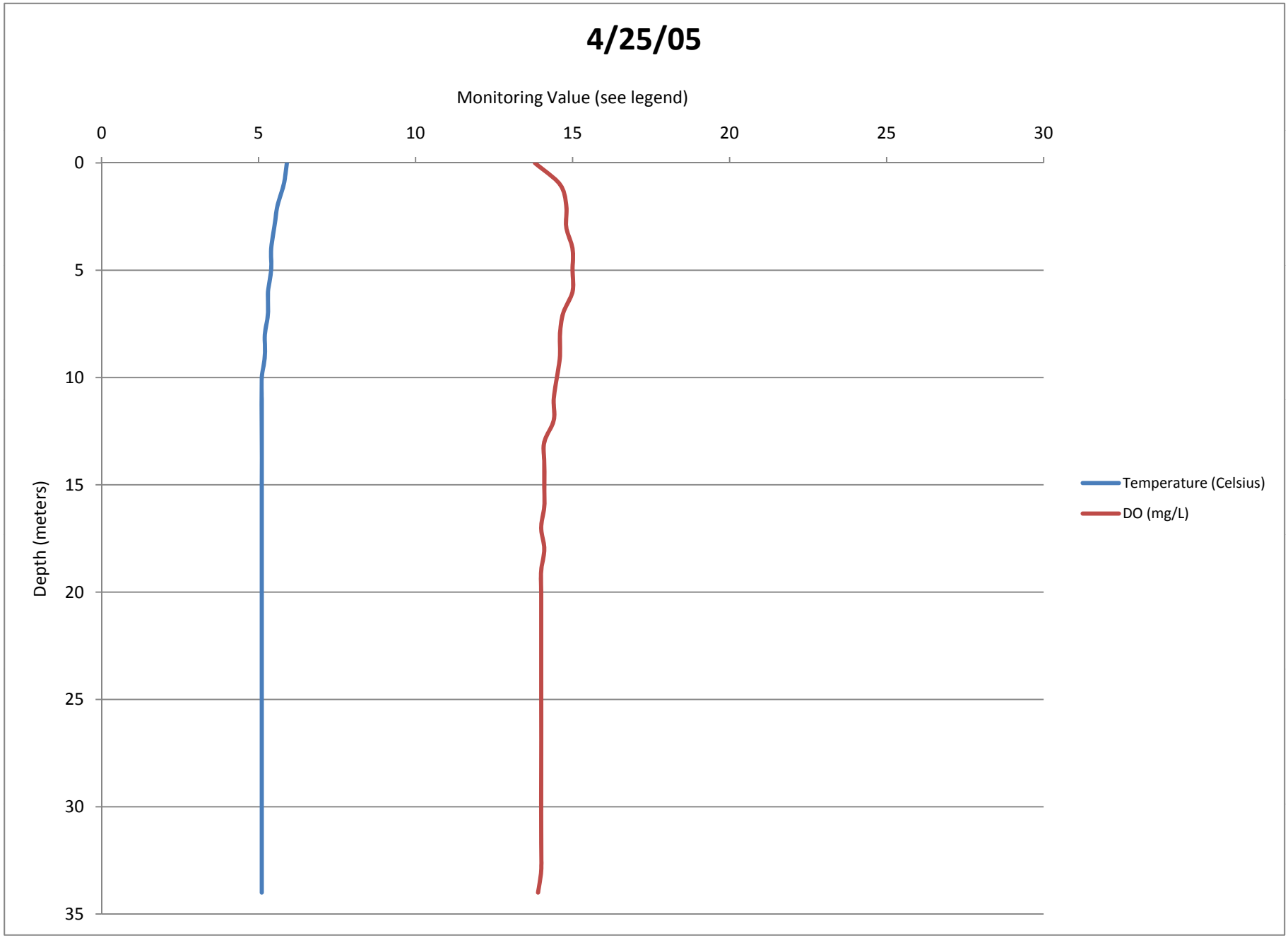
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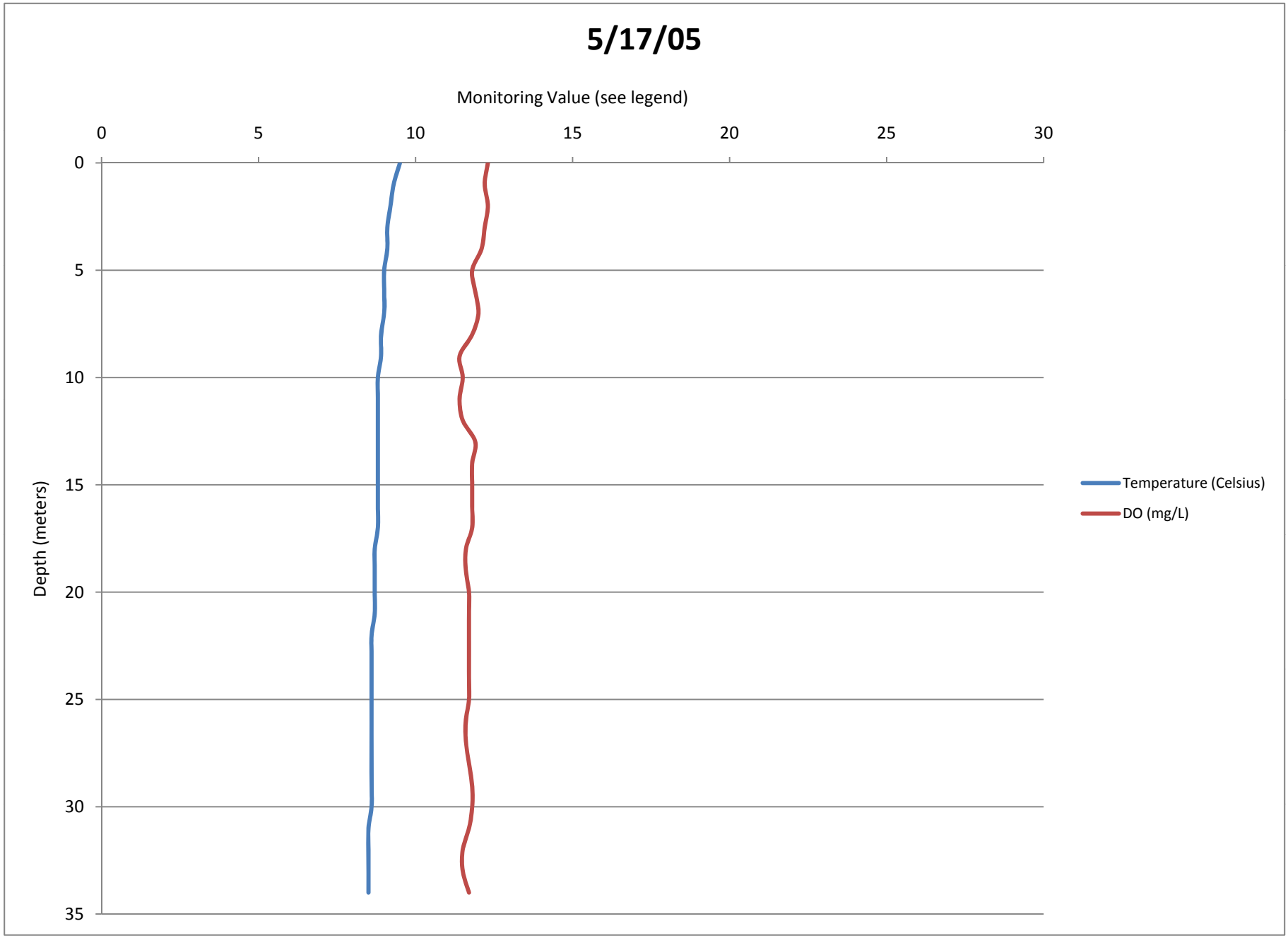
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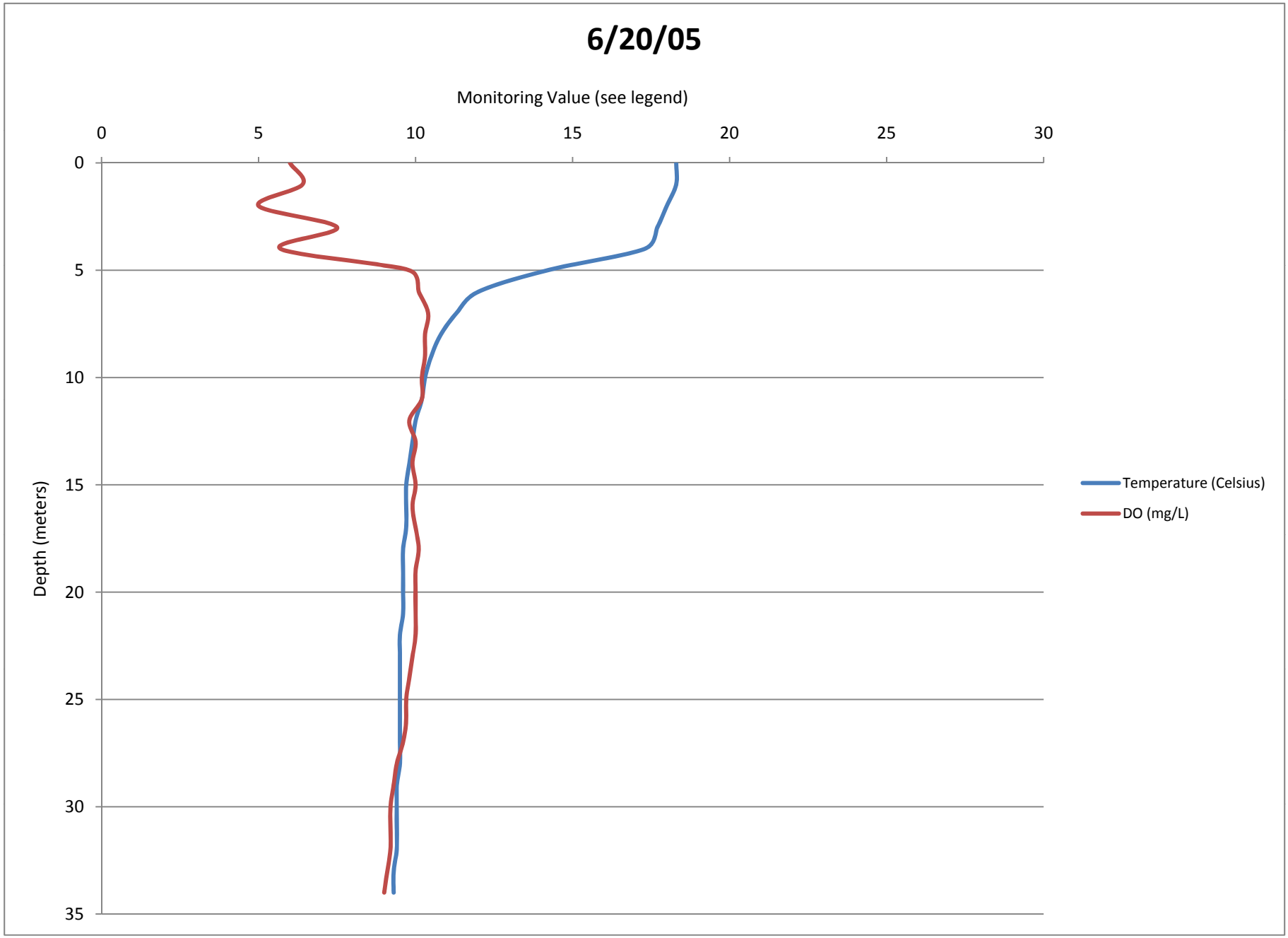
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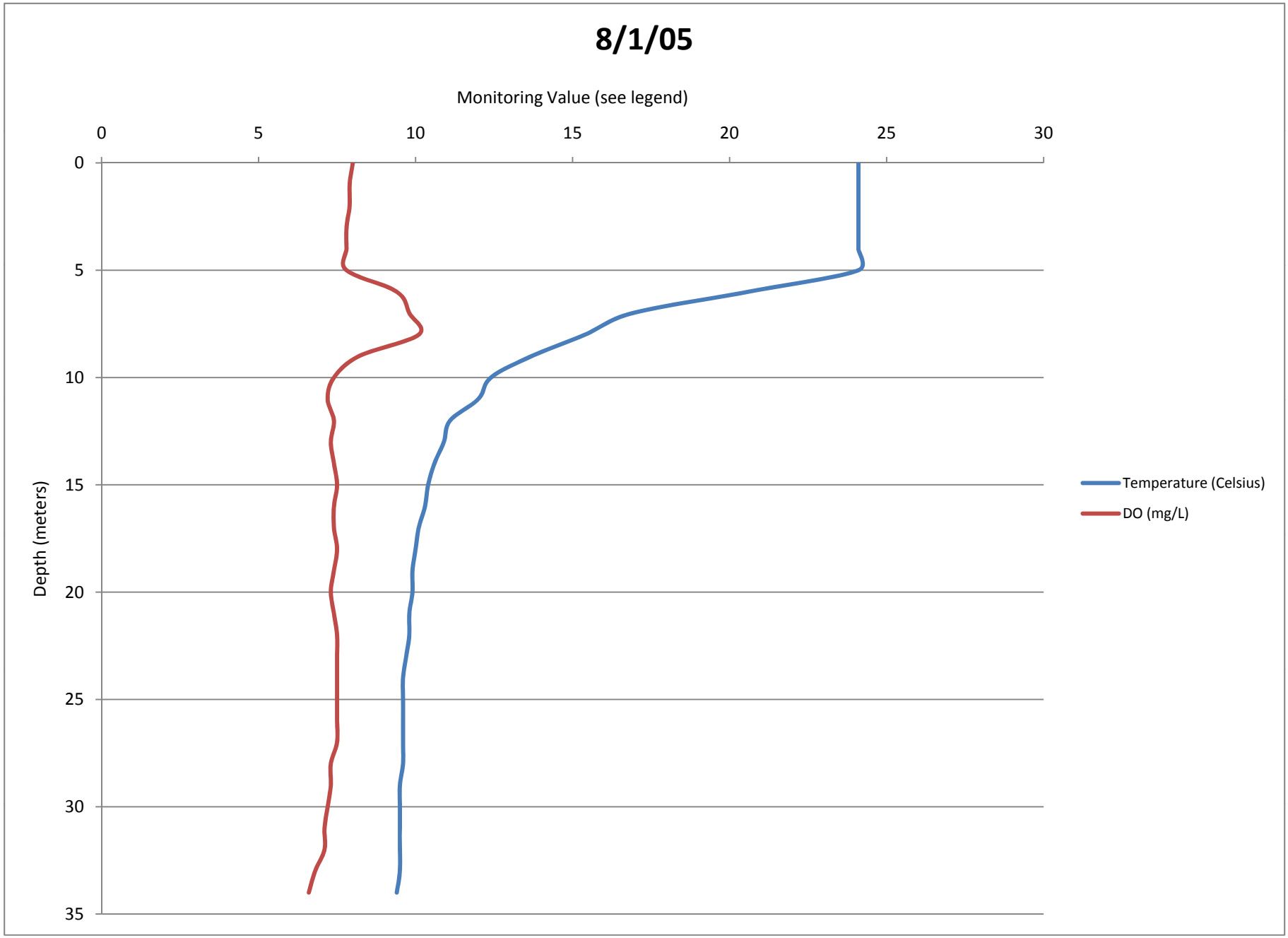
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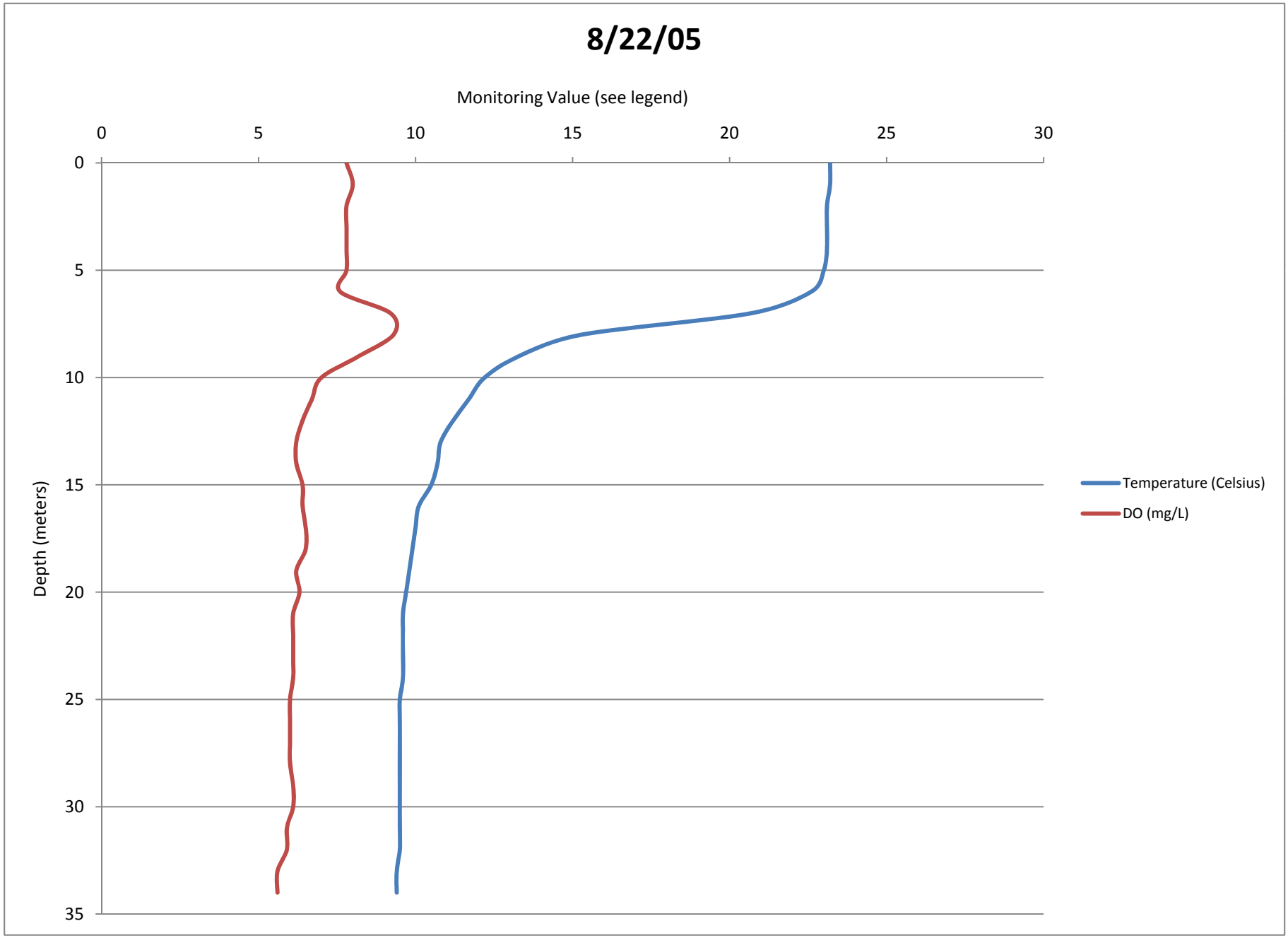
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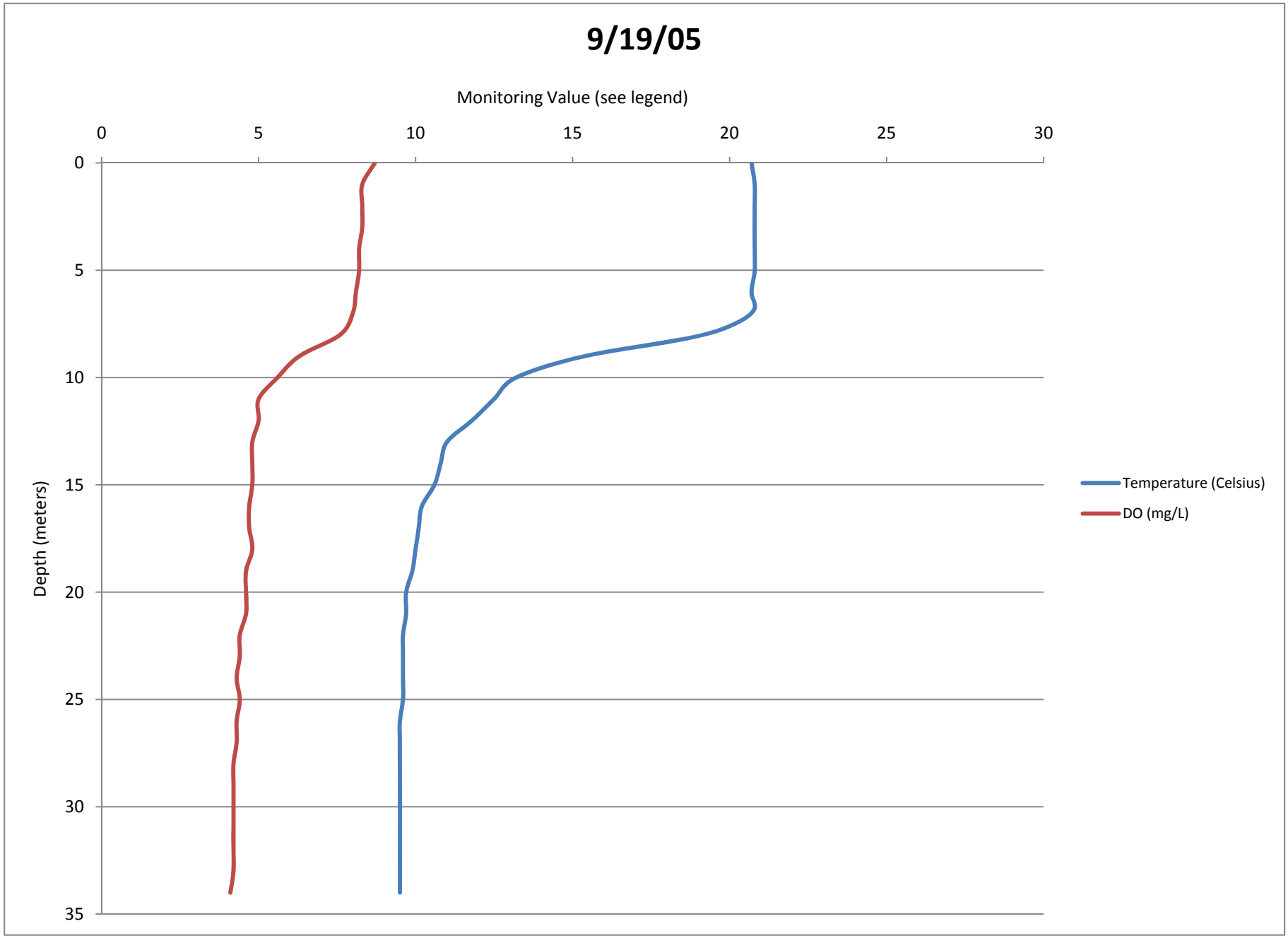
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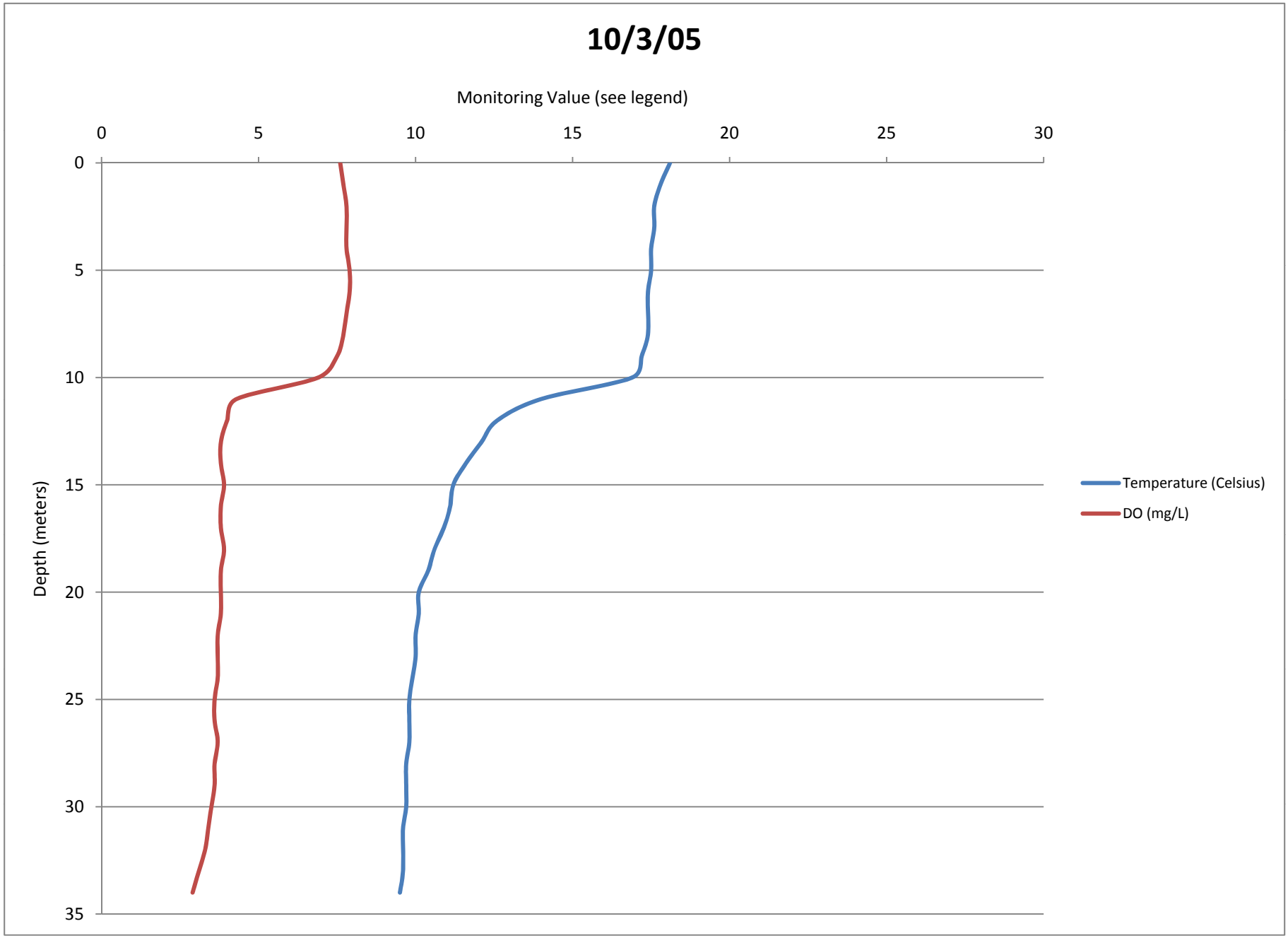
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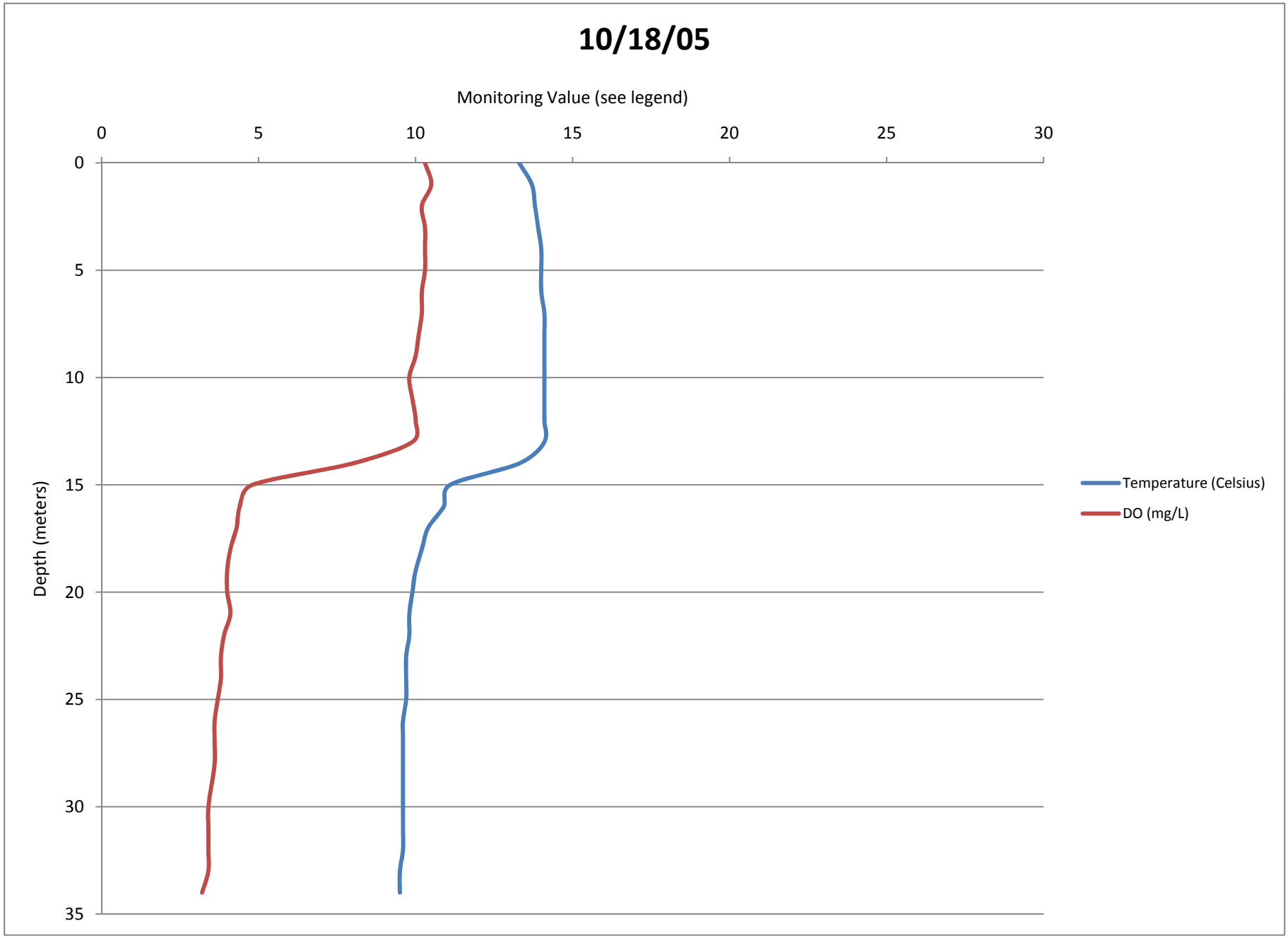
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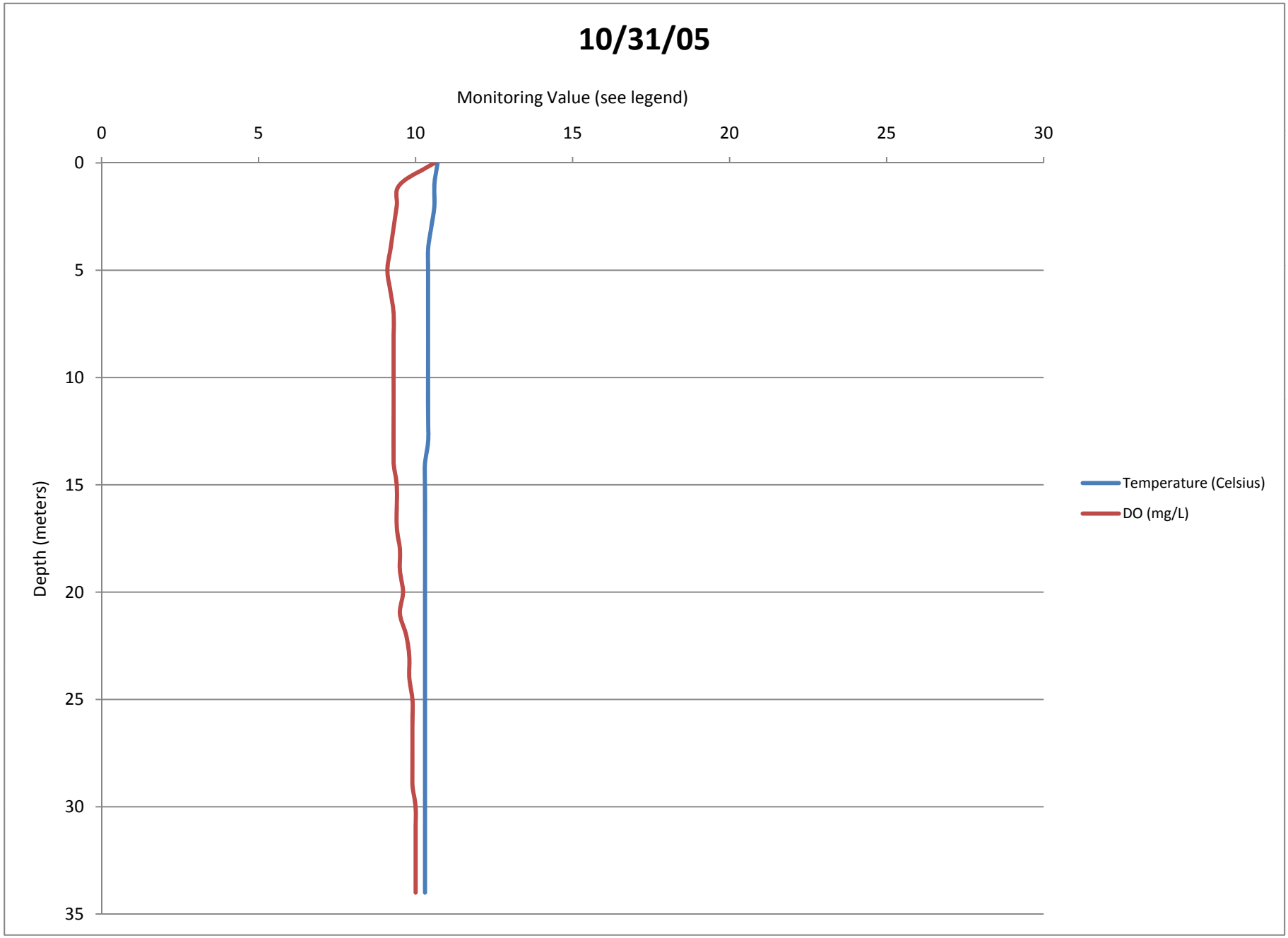
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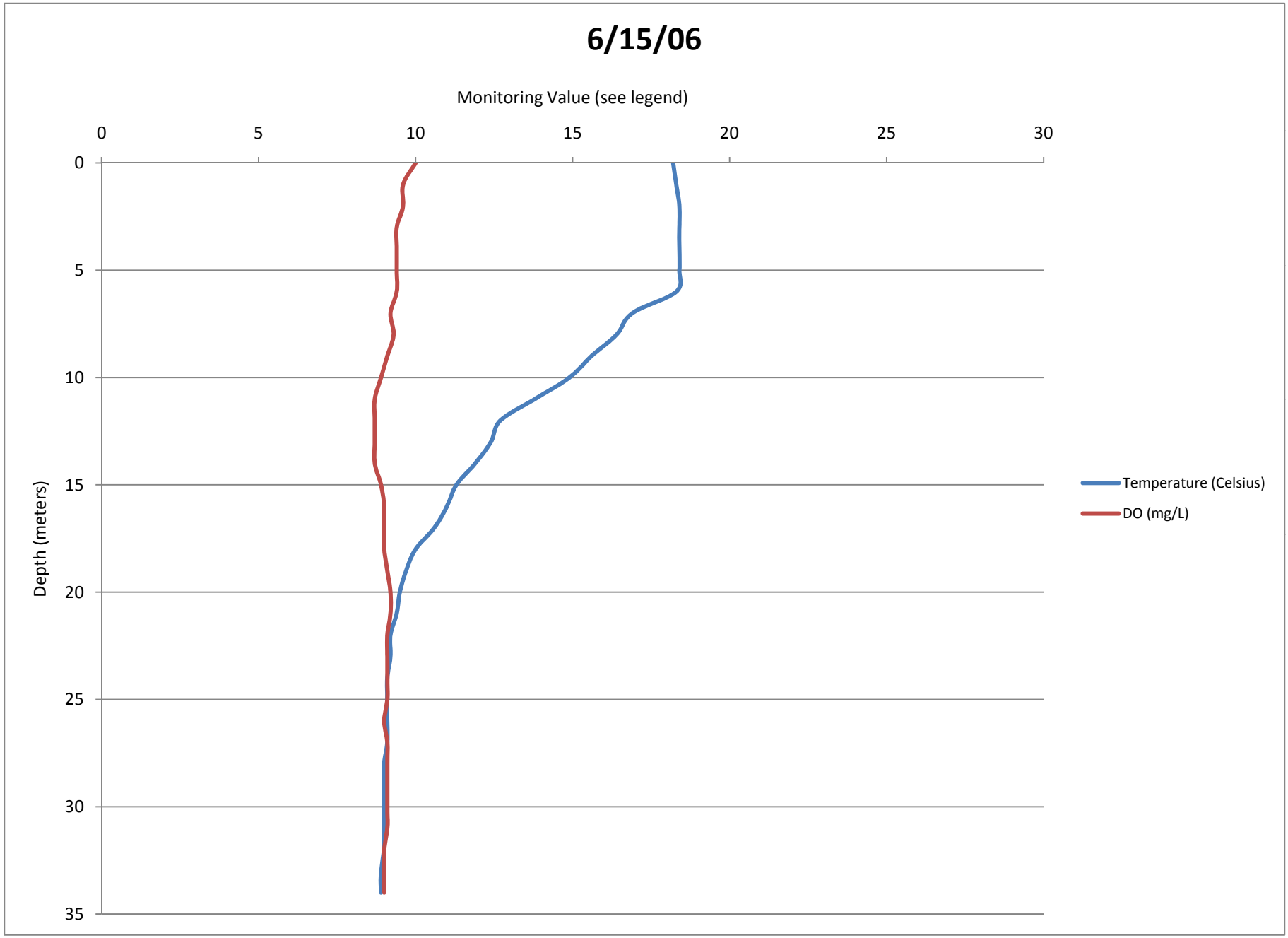
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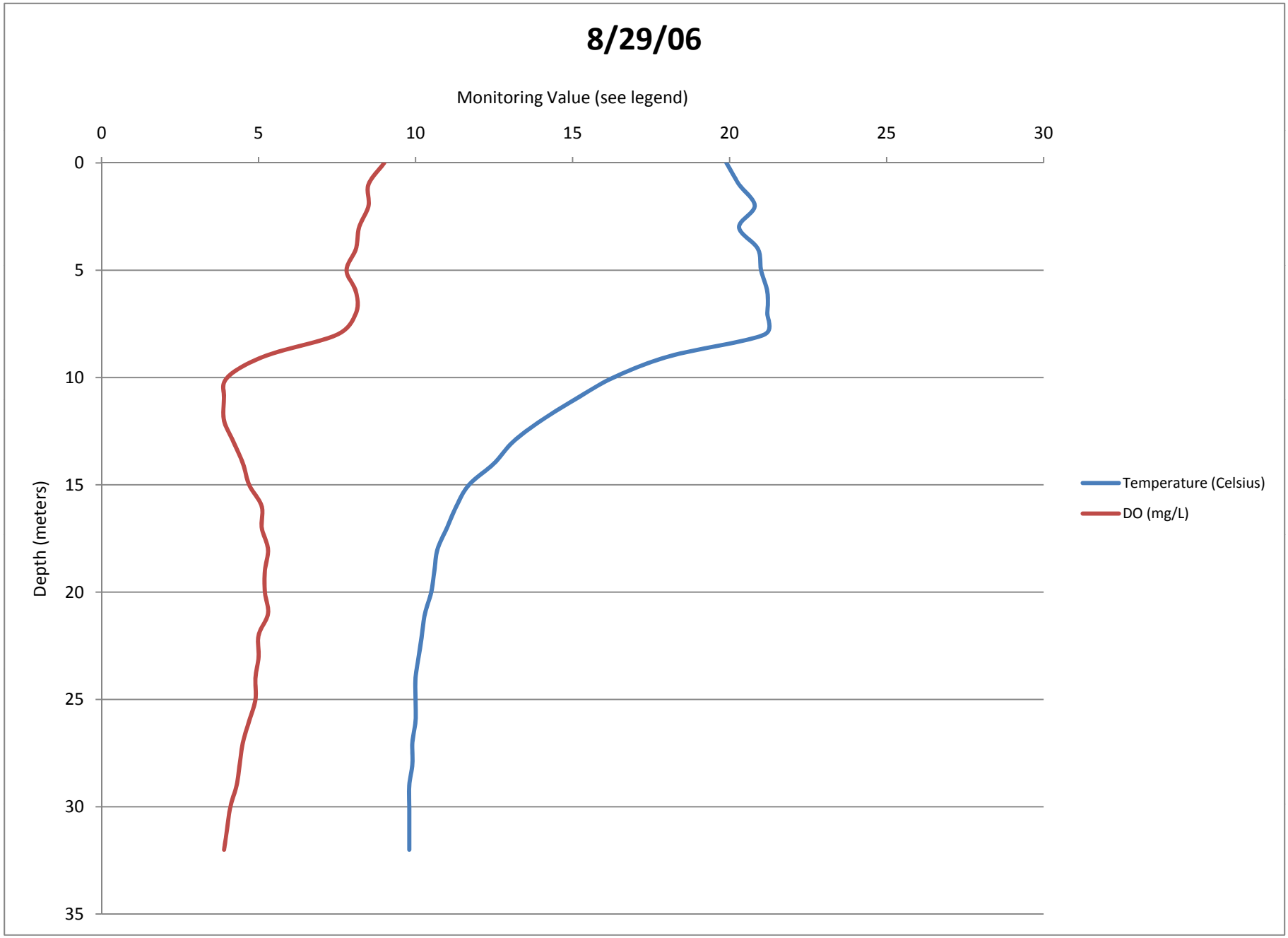
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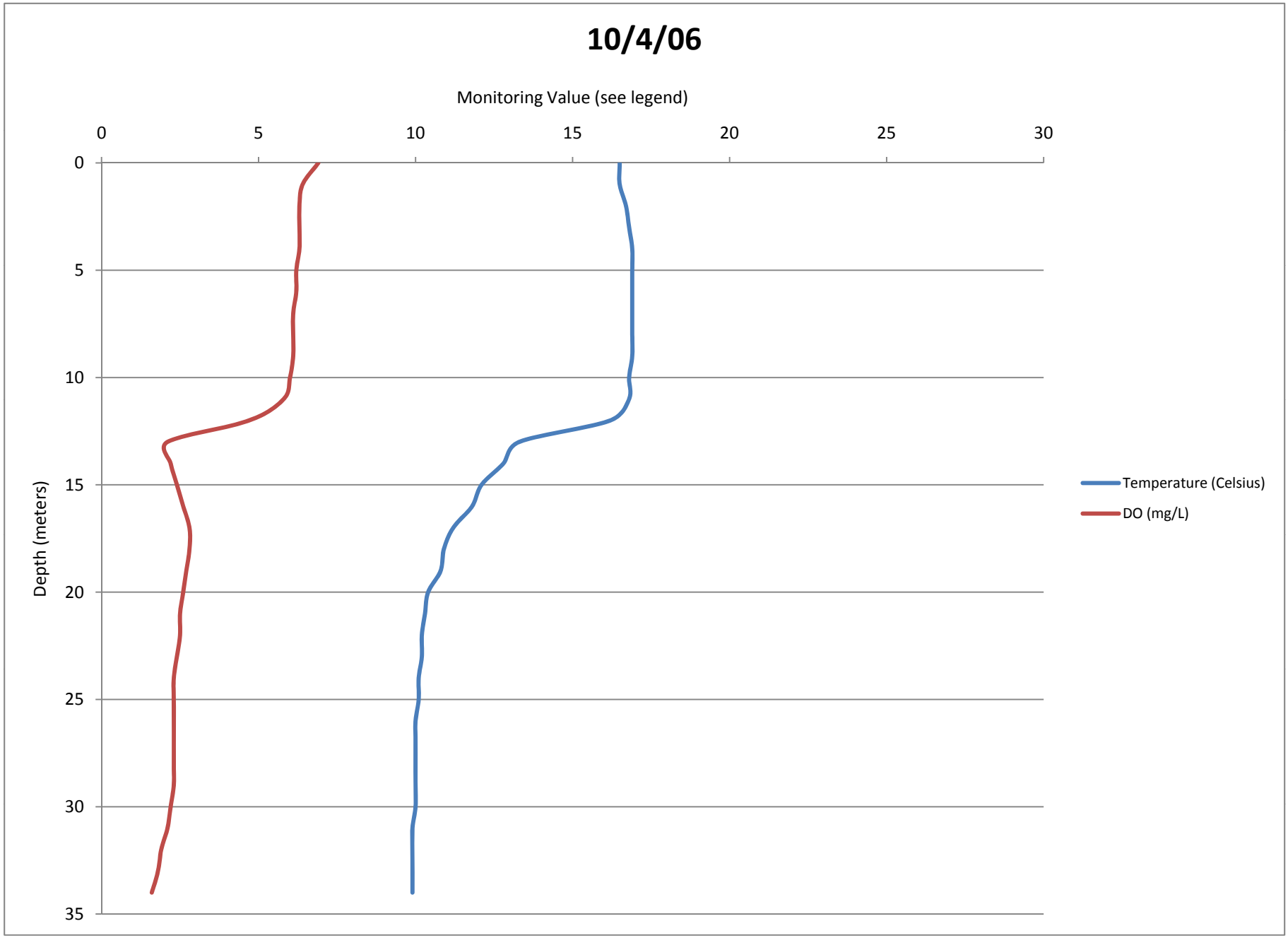
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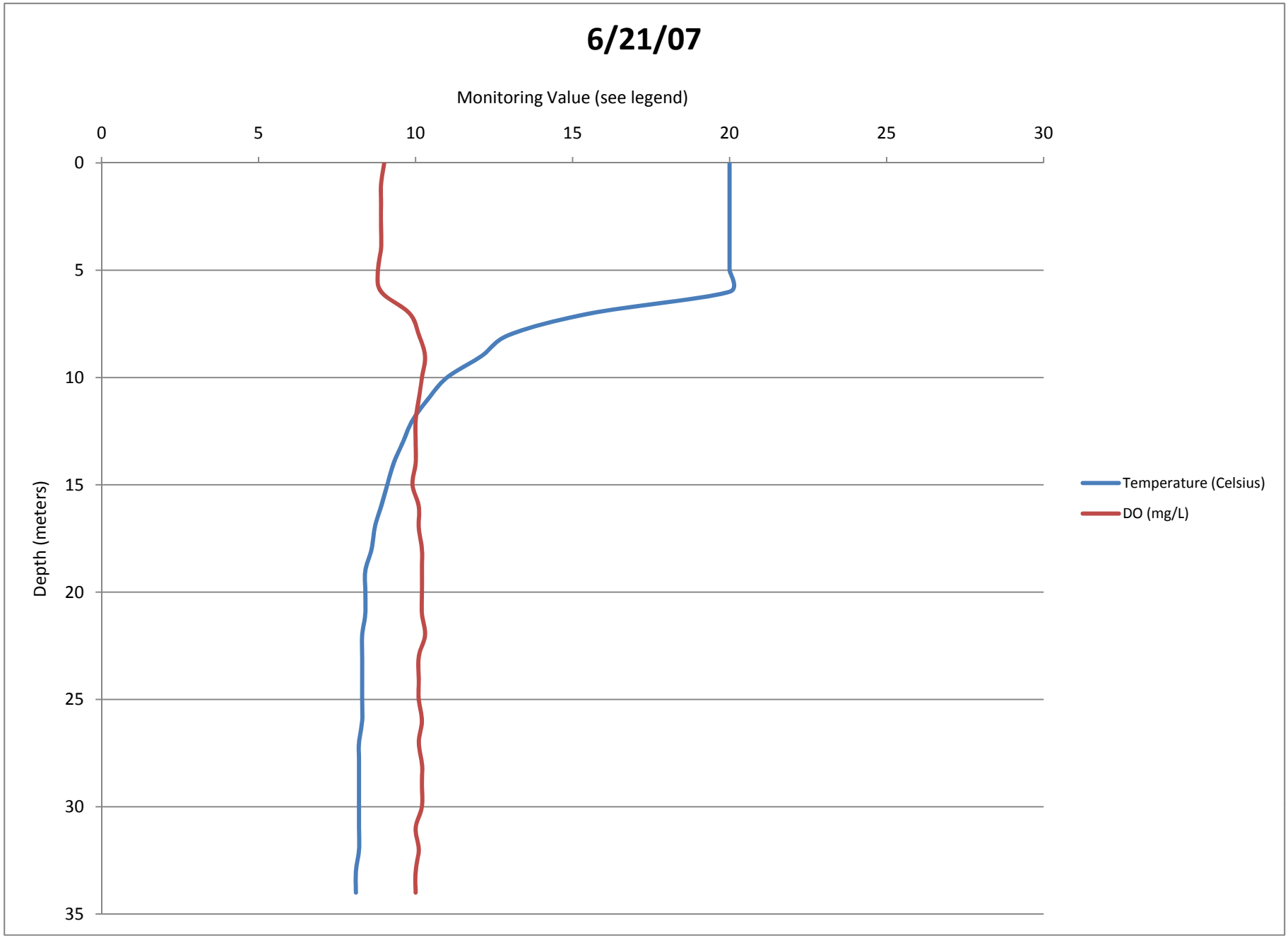
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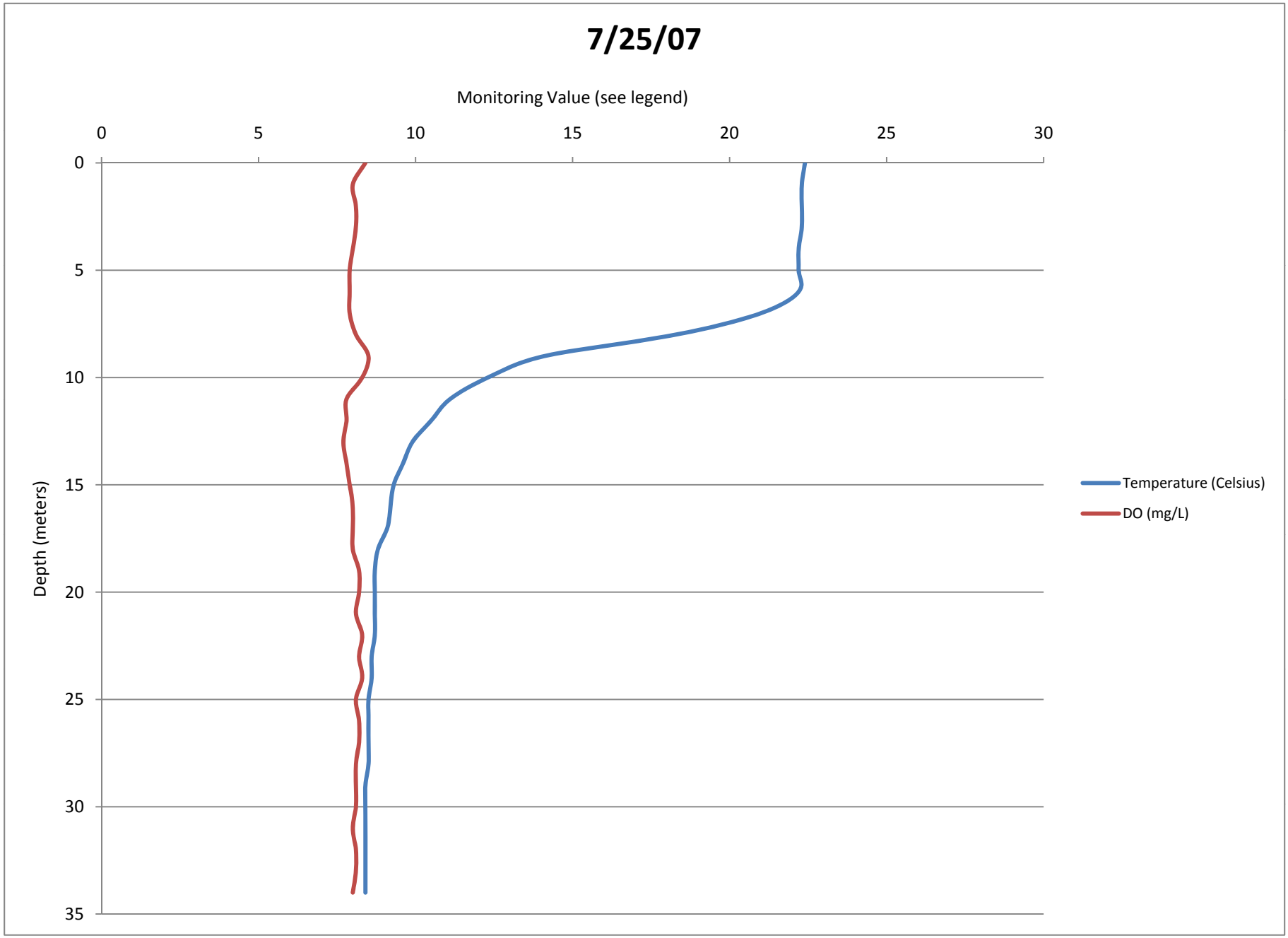
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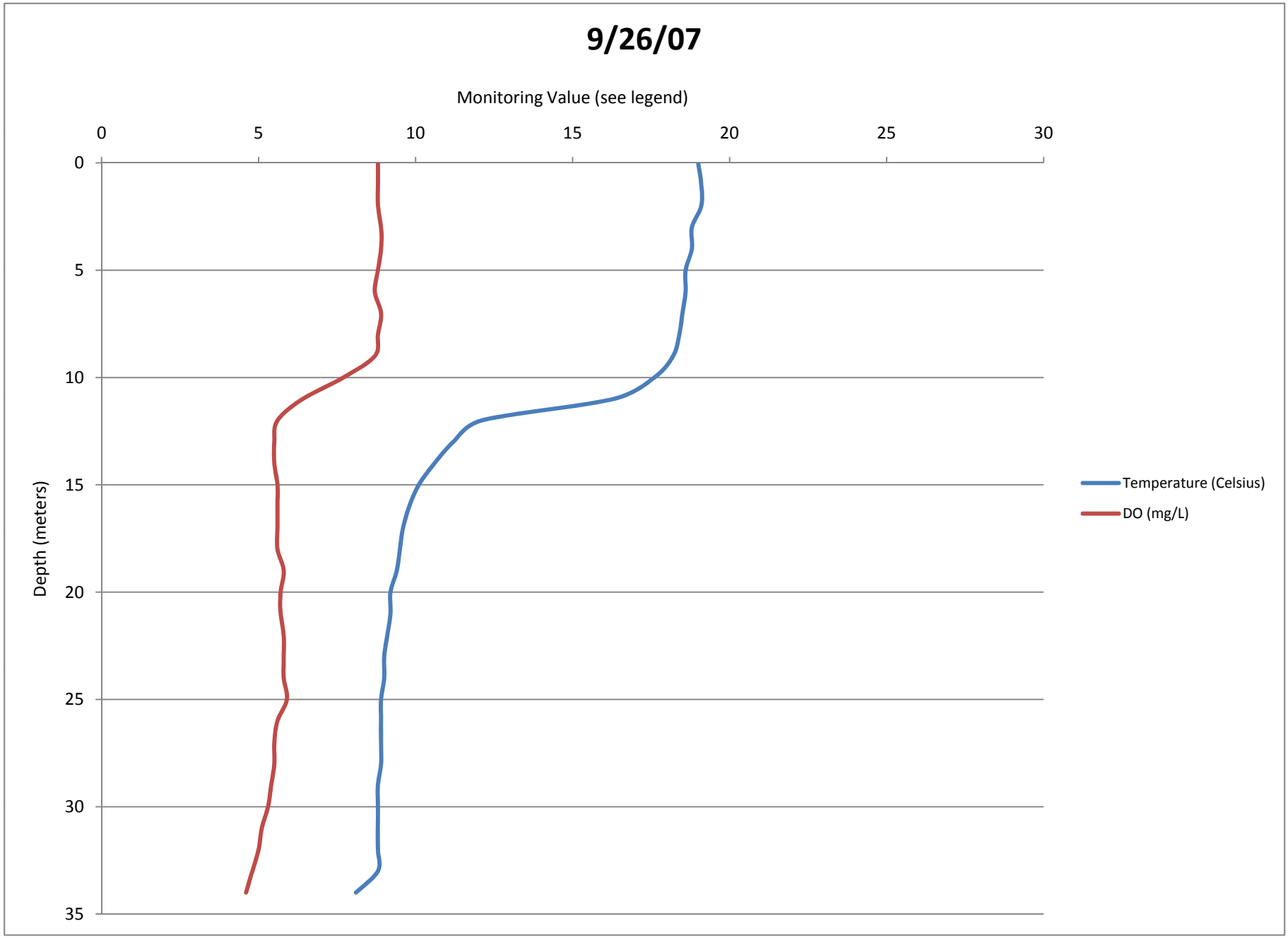
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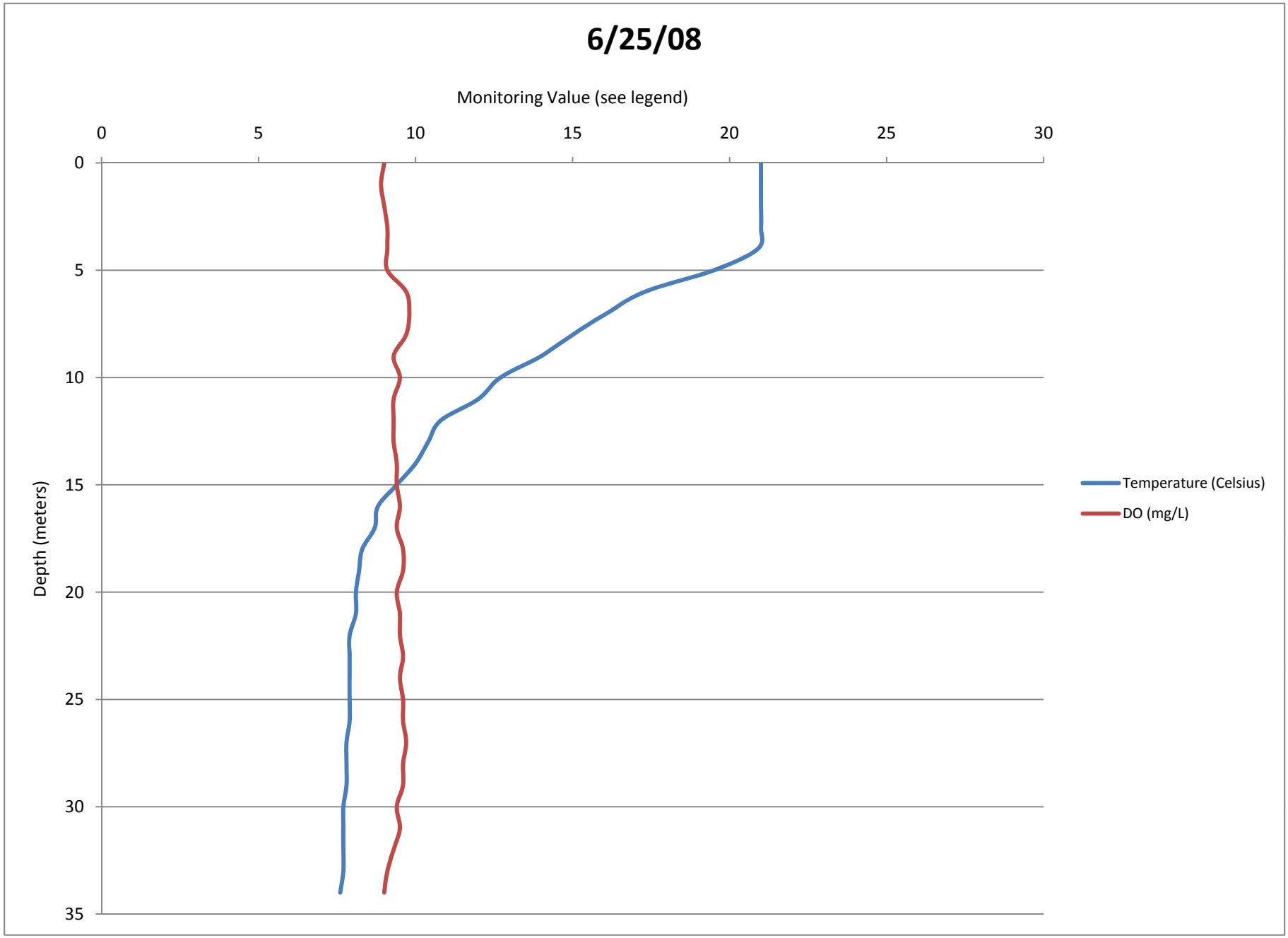
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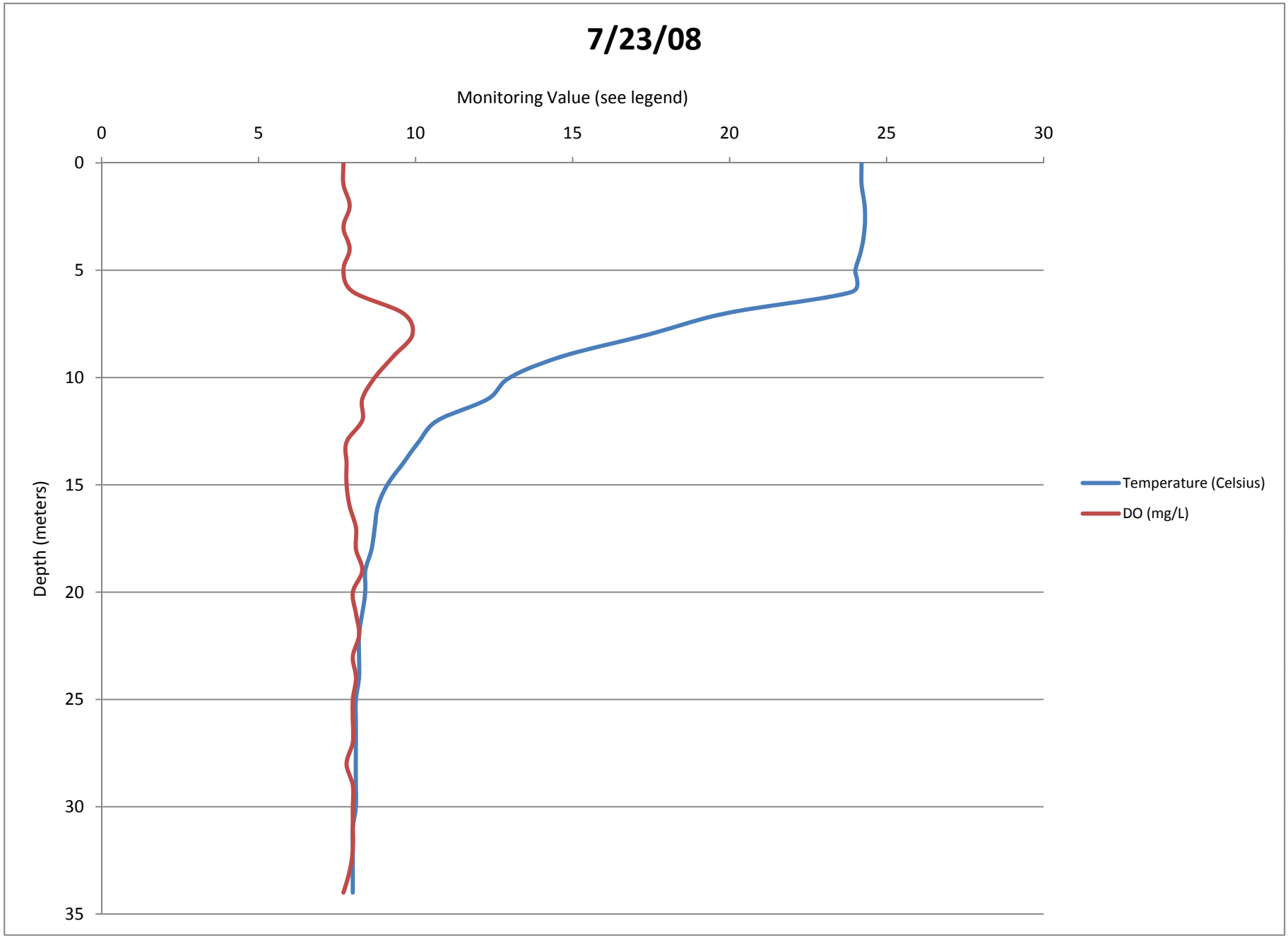
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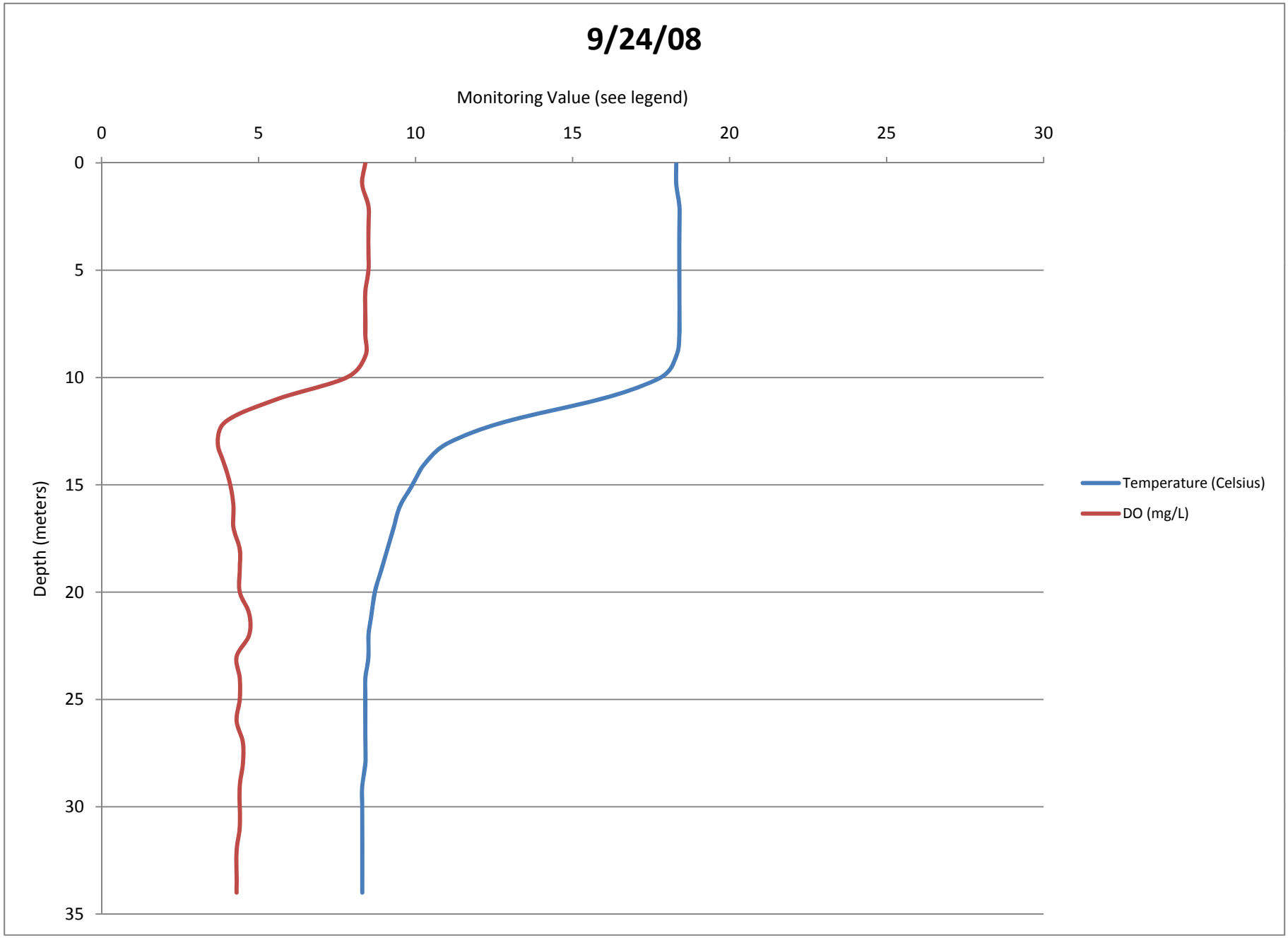
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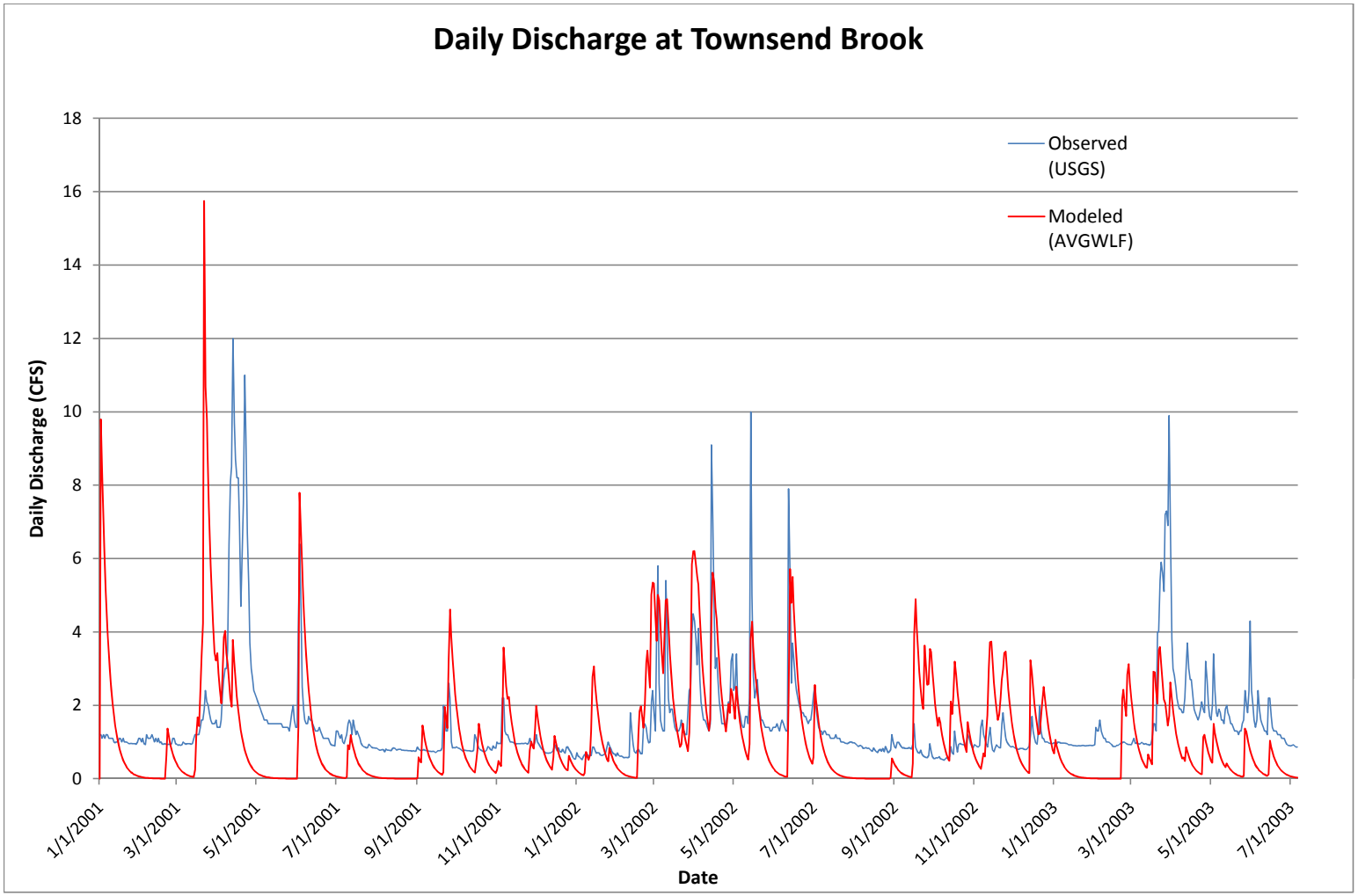
Temperature (Celsius)
DO (mg/L)

Appendix B
Final Calibration Curve and Flow Volumes



Average Streamflow Volume		
Data Source	Storm Period: 3/1/2002 to 7/1/2002 (10^6 ft^3)	Entire Period: 1/1/2001 to 7/6/2003 (10^6 ft^3)
Observed (USGS)	24.60	117.9
Modeled (AVGWLF)	24.24	91.44
Percent Difference	*1%*	*22%*

Appendix C
October 29, 2009 Septic Analysis Memorandum

MEMORANDUM

To:	Norm Lamie, P.E., Lake Auburn Watershed Protection Commission
From:	Rebecca Balke
Subject:	Lake Auburn Watershed Septic System Analysis
Job No.	222-2
Date:	October 29, 2009

The purpose of this memorandum is to present CEI's findings on whether the Lake Auburn Overlay District ordinance should be modified in regards to its septic system design criteria. The existing criteria are more stringent than the State's criteria because of the lake's status as the unfiltered water supply for the cities of Auburn and Lewiston. Also, the geology of the Lake Auburn watershed is characterized by coarse soils and some gravel, unlike the lodgement (basal) tills (characterized by dense and generally shallow restrictive layers with perched seasonal groundwater tables) found in much of Maine. Are the existing criteria adequate or should they be made more or less stringent considering this precious and sensitive source of drinking water? This memo report describes a logical approach to dissecting the issue so that an informed decision can be made.

LAWPC's Approach to Source Water Protection

To better understand why the Lake Auburn Watershed Protection Commission (LAWPC) has more stringent requirements than the State, it is important to recognize the significance of source water and watershed protection. The delivery of safe drinking water is the primary goal of the Lake Auburn Watershed Protection Commission (LAWPC), a commission formed to ensure that Lake Auburn remains as the source of drinking water for the cities of Auburn and Lewiston. To maintain this goal, the LAWPC follows the "Multiple Barrier Approach to Public Health Protection" (see Attachment A), which was initiated with the 1996 Safe Drinking Water Act Amendment, through the creation of a coordinated set of programs and requirements to help water systems maintain a safe supply of drinking water. These programs and requirements form a Multiple Barrier Approach that looks at all the components of a drinking water system and identifies safeguards or barriers needed to provide safe drinking water from the source to the consumer at the tap. This approach focuses on four key barriers:

1. Risk Prevention – Risk prevention focuses on implementing source water protection strategies to prevent contaminants from reaching the source. Protecting the water source is almost always more cost-effective than removing or inactivating contamination that has reached the source through treatment. Watershed management and protection is the primary mechanism for implementing risk prevention.

2. Risk Management – Risk management focuses on providing adequate treatment and system operations to remove any contamination that is present in the source water.

3. Monitoring and Compliance – Monitoring and compliance focuses on testing to detect and fix problems in the source and/or distribution system as early as possible.

4. Individual Action – Individual action focuses on consumer awareness and participation, both about the condition and quality of the source water and of violations that pose health risks.

The Lake Auburn Overlay District Ordinance (LAO) and septic requirements are one of the "Risk Prevention" barriers placed by the LAWPC and Cities to prevent contaminants from reaching Lake Auburn and were one of the factors considered in granting the Cities a filtration waiver. It is not in the LAWPC's best interests to try and lessen restrictions or embrace alternative technology that will break down these barriers.

Background

The Lake Auburn Watershed Overlay District ordinance has requirements for private subsurface sewage disposal systems that are more stringent than the State of Maine's requirements. The largest difference between the State requirements and the Lake Auburn Watershed Overlay District ordinance requirements are the vertical separation requirements between the bottom of the disposal field and restricting layer (e.g., seasonal high groundwater) and the requirements for suitable soil. The State of Maine allows a vertical separation of 12" to 18" on some soils, whereas the Lake Auburn Watershed Overlay District ordinance requires 24" separation in all cases. The State only requires 9" (proposed) of suitable soil be present on the site, whereas the Lake Auburn Watershed Overlay District ordinance requires 36" of suitable soil. Refer to Figure 1 for a comparison of depth, vertical separation and suitable soil requirements between the Lake Auburn Watershed Overlay District ordinance and the State of Maine requirements. Figure 2 provides a comparison of setback and suitable soil requirements between the Lake Auburn Watershed Overlay District ordinance and the State of Maine. Suitable soil refers to natural, undisturbed site soils (no fill) present on the site below the organic horizon.

Under the State's requirements, a mounded septic system can be built to meet the required vertical separation for the specific on-site soils as long as the minimum suitable soil criteria is met. For example, based on soil testing, a site is required to have a 24" separation to seasonal high groundwater, but there is only 9" of natural soil to seasonal high groundwater. The owner may bring in 15" of acceptable fill material to create the required 24" vertical separation distance. In doing so, a mounded septic system is created. The primary reason that Maine allows this is the clay soils that are predominant in much of the state.

Under the Lake Auburn Watershed Overlay District ordinance requirements, the bottom of the absorption area must be a minimum of 12" below the bottom of the organic horizon with a minimum of 36" of suitable soil beneath the organic horizon. These requirements do not allow for the construction of mounded systems.

How Does a Mound System Differ from a Conventional Subsurface System?

Conventional subsurface septic systems generally consist of a septic tank and a subsurface leach field or absorption area. Wastewater from the house enters the septic tank where it receives preliminary treatment to remove large particles. From there, it is typically gravity fed into a subsurface absorption field where it filters through existing soils, preferably 24-48" of soil (U.S. EPA, 1980) before reaching high groundwater, to complete the treatment process. The soil filters out smaller particles, removing some chemicals and nutrients and acts as a site for pathogens to be inactivated. These are simple systems that work well.

Mounded systems differ from conventional subsurface systems in that the absorption field is built at or above grade level to overcome site restrictions such as high water table or bad soils such as those with too much clay content. To overcome this elevation difference, homes may be built upslope of the mounded system or a dosing chamber is used to pump wastewater flows to the mounded absorption area. Thus, a mounded system often has three principle components: 1) a pretreatment unit (septic tank); 2) a dosing chamber (a second tank that is fed by the septic tank and which contains a pump to pump the wastewater into the mound); and 3) the elevated mound (absorption field).

The dosing chamber contains a pump, pump control floats and a high-water alarm float. The pump control floats activate the pump at high water levels, pumping it into the mounded absorption field and shut the pump off at low water levels. If equipped, the alarm is triggered if the effluent rises above the float level that activates the pump.

The mound is a raised drainfield consisting of a sand fill material containing a network of small diameter pipes to distribute the effluent. Effluent is pumped to the distribution system. Thus, the mound acts as a pressure-dosed sand filter to treat the effluent. The pressurized system distributes effluent evenly throughout the mound, where it trickles through the sand layer providing filtration of large particles and destroying some pathogens. The suitable naturally occurring soil beneath the constructed mound completes the treatment process, filtering smaller particles, removing some chemicals and nutrients, and acts as a site for pathogens to be inactivated. The table on the following page compares the advantages and disadvantages of mounded systems.

The bottom line is that mounded systems may be able to perform as well as conventional subsurface systems if designed, installed and maintained properly with adequate natural soils beneath the constructed fill, typically between 12 and 48 inches (U.S. EPA, 1999). However, because mounded systems are designed to be installed in otherwise unsuitable soils (e.g., high groundwater, low permeability), there is increased wastewater reaching groundwater and ultimately the surface water supply due to the increased number of septic systems that would otherwise not be allowed. Pollutants such as viruses and nitrates that are soluble can and will reach the lake in much larger quantities due to the increased number of systems, and depending on their proximity to the Lake, increased phosphorus loads can also occur. Since lake watershed management focuses on the limiting nutrient phosphorus, the quantification and significance of other pollutants tends to get lost. Nitrates are still a nutrient source for algal growth and increases could lead to increased algal blooms. Viruses can cause illness and are difficult and expensive to treat. Preventing these contaminants from reaching the lake is key to maintaining good raw water quality.

Advantages and Disadvantages to Mound Systems (Hygnstrom, revised 2008)	
Advantages	**Disadvantages**
• Can be used on land that is unsuitable for a conventional subsurface septic tank/drainfield system • Uses the top layer of naturally occurring soil, which is typically the most permeable and biologically active for treatment • Construction damage is minimized since minimal excavation is required • Can be used in most climates	• Higher design and construction costs • Quality of construction materials is extremely important to the success or failure of the system • Requires a more highly skilled installer – installers must be careful not to damage the limited permeable topsoil and organic zone • Lateral transport of contaminants may be more likely with high rain events since there is the potential for greater layering and compaction • The mound may have to be partially rebuilt if seepage occurs • Many systems require a pump instead of gravity to move wastewater through the system. The system will not work if there is no power. • High water use can overload the mounds, resulting in breakouts, repair and sometimes replacement • Increased maintenance – annual inspection of pump and mound to ensure proper operation

Vertical Separation

There are two considerations regarding separation from the seasonal high water table. One is the amount of natural soil available to remove pollutants and the second is the total vertical separation distance, including fill, between the bottom of the adsorption field and seasonal high groundwater (used for designing mounded systems).

Table 1 provides a comparison of state regulations for several New England States, including requirements for vertical separation to the seasonal high water table, the method required to define the seasonal high water table, the required suitable or naturally occurring soils (required as part of the vertical separation distance) and the soil percolation requirements for siting a septic system.

Table 1. Comparison of State Regulations				
	Final Vertical Separation to SHWT from bottom of Disposal Field	**Method of Identifying SHWT**	**Naturally Occurring Ground Surface (Site Suitability)**	**Percolation Rates**
Maine	12-24" depending on soil profile and design class	Soil mottling – presence of 2% low chroma mottles	• 9" outside shoreland zone area (proposed) • 15" within Variances to 9" for all (proposed)	Use site soil evaluation
New Hampshire	48" unless approved alternative system with lesser separation – allow 30" separation with Presby system	Soil mottling – 2% or more distinct or prominent redoximorphic features that increase in % with depth	• 15" above SHWT • 18" above bedrock	2 to 60 min/inch
Massachusetts	• 48" with >2min/inch • 60" with <2min/inch (Include GW mounding for >2000 gpd)	Soil color using Munsell supplemented by observation during annual high water table, USGS correlations		2 to 60 min/inch
Vermont	• 36" Septic tank effluent system • 24" Filtrate effluent • 24" and 18" to induced GW mound – Filtrate >4.5gpd/lf & performance based • 36" to induced GW – Mound systems >1000 gpd & in-ground/at grade systems >2000 gpd	Soil mottling or GW level monitoring	• 24" at <120 min/inch - Prescriptive • 18" at <120 min/inch – Enhanced Prescriptive • Induced GW Level plus 6" – Performance Based	4 – 60 min/inch – Absorption trenches/beds – (soil modifications allowed for perc rates faster than 1 min/inch)
Connecticut	• 48" over ledge (24" must be natural) • 18" over impervious soil or SHWT • 96" over ledge and 24" over SHWT – when perc faster than <1 min/inch	Site testing or monitoring (5 consecutive weekly readings in most restrictive 30-day wet season)		1 – 60 min/inch when GW is min 18" below test hole
Rhode Island	• 36" over SHWT • 48" over SHWT for certain soil categories within specified critical resource areas and drinking water watersheds • 60" over bedrock	Hydromorphic soil features – redox depletions & concentrations occupy 2% or more, vary 2 or more units in chroma or presence of depleted horizon	• 24" over SHWT • 18" if using bottomless sand filter • 48" over bedrock Within Specified Critical Resource Areas • 60" over SHWT • 84" over bedrock	For sites without soil evaluation (data prior to new rules), perc rates were used. >40 min/inch unsuitable <10 min/inch unsuitable

Based on this review of six states, Maine has the least stringent vertical separation and suitable soil requirements, requiring only 12-24" vertical separation and 9 to 15" suitable soil, whereas the other states require 36-60" vertical separation with a minimum of 15" or more of suitable soil. Discussions with the Maine Subsurface Wastewater Program reveal that most Maine systems are built at or above the ground surface with the required 12-24" separation and that a 4-5 foot separation from seasonal high groundwater using the State standards for identifying the seasonal high water table (2% low chroma mottles) would result in a finished grade 6-8 feet above the existing ground. This indicates that the Maine standards are also based on development/growth considerations to work with restrictive layers common throughout Maine.

Pollutant Removal

Phosphorus is an element that can turn pristine lakes like Lake Auburn from clear to green, weedy and polluted in a relatively short period of time. Too much phosphorus promotes algal blooms that cause hard to remove taste and odor problems in drinking water. Lake Auburn is even more sensitive to increased phosphorus because it is an unfiltered water supply and must meet stringent turbidity and bacteria criteria that would be encouraged by even minor increases in phosphorus loading from the watershed.

Regarding the removal of phosphorus, near surface soils have more phosphorus removal capabilities than deeper soil horizons. With phosphorus, soil surface area is very important. More soil weathering has occurred closer to soil surface and therefore more surface area is present and more soil coatings of iron, aluminum, manganese, and calcium which react with phosphorus and pull it out of solution. Keeping wastewater application as shallow as possible also helps with phosphorus and nitrogen uptake by plants (grasses are best). While it does not provide long-term removal, it does create long-term recycling of these nutrients so they stay in the near surface soil ecosystem where there is lots of competition for nutrients. These near surface soil zones are also highly biochemically reactive, so they can promote degradation of wastewater microbes, protecting water supplies (George Loomis, personal communication).[1]

Pollutant removal should be the key consideration for setting a vertical separation distance. EPA recommends 24-48 inches for adequate pollutant removal (U.S. EPA, 1980). The greater the depth, the better the removal. Greater vertical separation is especially important in highly permeable soils, where wastewater flows quickly through the soil media, resulting in less effective treatment. The following discusses vertical separation as it pertains to specific pollutants.

Nitrogen

In most aerobic soils, nitrates move quickly and readily into groundwater without reduction. Dilution is often the only form of reduction. Several studies indicated that nitrification occurred within mounds and subsequent denitrification (reduction of nitrates) occurred at the mound-soil interface. However, the amount of denitrification decreased with time as the carbon within the soil surface was exhausted. Other alternative systems have shown a reduction in nitrogen concentration. (Stolt and Reneau, 1991).

[1] George Loomis, Program Director, New England Onsite Wastewater Training Program Cooperative Extension at URI, Email Communication 4/21/2009.

Phosphorus
Phosphorus (P) readily adsorbs to soils containing reactive iron (Fe), aluminum (Al) and calcium (Ca). The primary processes in phosphorus attenuation are adsorption and precipitation with adsorption acting as the primary removal mechanism followed by the slower precipitation reaction. Phosphorus is more likely to reach groundwater with high water tables, coarse textured soils, increased flow rates, high loading rates, soils with low phosphorus adsorption capacity or when phosphorus capacity is met. Studies have suggested a minimum 60 cm (2 foot) separation distance for adequate phosphorus removal. In time, the adsorbing capacity of the filter media will eventually be filled and the degree in which phosphorus is attenuated will be reduced. (Stolt and Reneau, 1991).

The *Scope Newsletter* compiled a review of a number of papers covering nutrient contamination from septic tanks and other decentralized sewage treatment systems. Overall, phosphorus contamination from septic tanks appeared to be limited, due to retainage in septic tanks and soils. However, some studies did find long-term migration of phosphorus in the groundwater zone over long periods of use, with phosphorus above background levels detected up to 75 meters (~250 feet) away from the septic system. This was more apparent in sand substrates. (Scope Newsletter Number 63, January 2006).

Bacteria
The primary process for bacteria attenuation in soil is adsorption and filtration. Movement of bacteria through well drained, fine and medium textured soils is minimal; however numerous studies show significant movement of bacteria in soils with coarse textures, considerable structure, or high water tables. (Stolt and Reneau, 1991).

A compilation of research prepared by Selden Hall indicated that substantial bacterial and viral removal occur within the first foot of unsaturated soil, and removal is nearly complete within 60 to 120 centimeters (24 to 48 inches) beneath the adsorption field (Hall, 1990), depending on soil conditions, with sandier soils requiring the greater depths. This is consistent with the U.S. EPA's findings and recommendations.

Viruses
Viruses are very small microbes, smaller than any bacteria. Due to their small size, filtration by soils is minimal and adsorption is the primary process for removal. Viruses move more rapidly in coarse textured soils. Several studies indicated that survival rates, and degree of movement were greater for viruses than those of fecal bacteria. U.S. EPA identified research showing significant (e.g., 3-log) removal of viruses in 60 to 90 cm (24 to 36 inches) of sandy media (U.S.EPA, 2002).

Based on the compiled research, a vertical separation of between 24 and 48 inches is recommended for adequate pollutant removal. The Town of York, ME requires a minimum of 24 inches of original soil present between the bottom of the subsurface disposal area and the most limiting factor (Town of York, ME Zoning Ordinance. 2008).

Emerging Contaminants

Concerns over the fate and transport of other less studied contaminants, such as endocrine disruptors and pharmaceutical and personal care products (PPCPs), have recently been raised. The endocrine system, also referred to as hormone system, regulates biological processes in the body, including brain and nervous system development, reproductive systems, metabolism and blood sugar levels. Endocrine disruptors are compounds that cause adverse effects to this system in wildlife and humans and include man-made substances including synthetically-produced hormones (pharmaceuticals) and chemicals for industrial use (e.g., cleaning agents, pesticides, plastics).

Endocrine disruptors and PPCPs typically find their way into source waters by sewage outflows (American Water Works Association. Retrieved September 14, 2009). USGS has performed multiple investigations throughout the country on the presence of endocrine disruptors in surface waters and their effects on fish. Many examples of endocrine disruption in the environment have been observed and USGS is continuing to study its prevalence (USGS. Retrieved September 14, 2009).

As an emerging contaminant, there is still a great deal of ongoing research on the health effects and prevalence of endocrine disruptors. However, existing research on the removal of other wastewater contaminants, as outlined above, shows us that greater vertical separation between leaching beds and restrictive layers results in greater pollutant removal. This same logic is expected to apply to these emerging contaminants and less stringent criteria are not likely to provide adequate treatment.

Should the LAO Requirements be Modified?

No. There are several reasons why. First, it is important to note that water quality impacts associated with changes to septic system design criteria must include all net impacts, not those just associated directly with the septic system. For example, if the use of mounded systems allowed for more development to occur, then there would be an additional pollutant loading associated with that development, both from the additional septic load and through stormwater runoff. Thus, it is the net loadings over existing conditions that requires attention.

As noted earlier, the biggest differences between the State requirements and the Lake Auburn Watershed Overlay District ordinance requirements are that the Lake Auburn Watershed Overlay District ordinance requires 1) a greater vertical separation distance (in some cases); 2) a greater depth of suitable soil; and 3) the absorption field to be located completely below the surface (no mounding).

The use of less stringent criteria, such as those allowed by the State of Maine, in the Lake Auburn watershed would allow for more development in the watershed, as parcels that can’t meet the Lake Auburn Watershed Overlay District ordinance criteria for a septic system would be able to meet more lenient requirements. In fact there is little to be gained from less stringent criteria yet potential risks that are untenable. New contaminants like viruses, endocrine disruptors and others are likely to result in more treatment in the future, not less, and although it is too early to predict what will be needed in terms of greater treatment, it is much more likely to be called for in the future. High quality drinking water sources such as Lake Auburn are particularly worthy of even greater protection.

The potential associated impacts would include: 1) increased pollutant loadings from septic systems, particularly nitrogen which is extremely soluble and difficult to remove (nitrates); and 2) increased pollutant loadings from increased stormwater runoff associated with the development, which is expected to have greater impacts than the septic systems alone, especially for phosphorus. It is the combined net loading over existing conditions that is of concern.

To evaluate these impacts, CEI performed a simplified buildout analysis within the Lake Auburn watershed within the Town of Auburn. The simplified analysis used United States Department of Agriculture (USDA) natural Resources Conservation Service (NRCS) soils data to identify depths to groundwater. It was assumed that all areas with a depth to groundwater between 12 and 36 inches could not support a septic system under the Lake Auburn Watershed Overlay District ordinance, therefore could not support a home under the existing regulations. These areas were then assumed to be developable under State regulations since these areas would meet the site suitability criteria for a mounded system. A 100 foot shoreland buffer was removed from these areas and the remaining land was considered developable under the existing zoning. Lot frontage and setbacks were not considered as these can change over the years and/or property transfer could occur to meet setbacks.

Septic systems within 300 feet of the shoreline were used to determine phosphorus loads from septic systems to the Lake. Phosphorus loads carried with stormwater runoff were considered for all development under the less stringent requirements, regardless of its proximity to the shoreline. The results revealed the potential for an additional 290 septic systems within 300 feet of the Lake from buildout following the existing septic system requirements.
Based on a residential design flow of 270 gallons per day per three bedroom dwelling, the less stringent State standards would result in an additional 78,300 gallons per day of residential wastewater flow within 300 feet of the shoreline. This would result in an additional 225 pounds of phosphorus to the Lake from septic systems and an additional 125 pounds of phosphorus from stormwater runoff associated with the development. This an overall 7% increase in phosphorus loads to the Lake from buildout under the existing ordinance.

Cost of Degraded Water Quality

The Cities of Auburn and Lewiston received a waiver from filtration from the State of Maine and U.S. EPA when filtration was originally required of most surface water systems. The reason was that Lake Auburn is pristine and has high clarity and very low levels of phosphorus, pathogens and other pollutants. This is an enviable situation enabled by the long history of protection of the lake, a situation that has saved the two cities millions of dollars in treatment and operation costs. Diligent monitoring of water quality and extensive land and easement purchases over time have allowed the cities to maintain this waiver since 1993, resulting in a huge cost savings and improved public safety of the drinking water.

The LAWPC follows a multi-barrier approach to safe drinking water. This approach ensures that “barriers” are in place from the source to the consumer to eliminate threats or minimize their impacts. Watershed protection is the first line of defense or first “barrier”, with the overall goal of preventing contamination from the watershed from reaching the water supply. It is more cost effective to prevent contaminants from entering the water supply than it is to allow the contaminants to enter the supply and then try to remove them through treatment. This approach is consistent with the criteria for avoiding filtration, which includes maintaining a watershed control program which minimizes the potential for contamination by *Giardia*

lamblia cysts and viruses, as outlined in 40 CFR 141.71. The State determines whether the program is adequate based on the comprehensiveness of the watershed review; the effectiveness of the system's program to monitor and control detrimental activities occurring in the watershed; and the extent to which the water system has maximized land ownership and/or controlled land use within the watershed. The ordinances and programs in place at the time the waiver was granted were key factors in granting this waiver and changes to these programs, particularly changes that allow for more growth and net loadings to the Lake, could risk the losing of that waiver.

Should the Lake Auburn Watershed Protection Commission (LAWPC) Allow Mounded Systems in the Lake Auburn Watershed?

No. In addition to the higher potential for failure of mounded systems if they are not designed, installed and maintained correctly, there is a significant impact associated with the increased development and number of septic systems that the use of mounded systems would allow within the watershed.

To avoid these impacts, the Lake Auburn Watershed Protection Commission (LAWPC) has the following options:

1) Maintain ordinance as is not allowing the use of mounded systems;
2) Allow mounded systems and use zoning to control the density of development in the watershed to avoid the increase associated with the use of mounded systems under existing zoning. This would involve a significant reduction in the allowable density, particularly in the Rural Residential District; and
3) Require controls that result in no net increase in pollutant loadings from the proposed development. This may include more stringent stormwater controls associated with new development that require all stormwater runoff to be handled on-site, eliminating the stormwater impacts to the Lake associated with the new development.

Does a Tiered Set of Requirements Make Sense for the Lake Auburn Watershed?

Considering that most of the increased phosphorus load (the limiting nutrient for algal growth which can lead to taste and odor problems requiring treatment) is expected to come from the increase in development, rather than from the septic systems themselves, and the entire watershed contributes to the phosphorus load to the Lake, a tiered system based on distance from the water supply or within the direct or indirect watersheds may not do much in reducing total pollutant loads to Lake Auburn. However, research shows that pollutant removal is greatly influenced by soil types, with sandy soils providing less effective pollutant removal than finer soils. Thus, the LAWPC may consider increasing the required vertical separation in sandy soils from 24" to 36", while maintaining the existing 24" separation requirement for all other soils. Note that the State of Rhode Island requires a statewide 36 inch separation, and 48 inches in critical resource areas, including surface water reservoir watersheds.

Other Improvements/Changes to the Lake Auburn Watershed Overlay District Ordinance

The Auburn Water District and Lewiston Water Division are responsible for providing clean, affordable water to their customers. Maintaining the filtration waiver is an important component to meeting this responsibility. The LAWPC should consider the following recommendations to strengthen the existing ordinance and improve protection of the Lake.

Setback – The Lake Auburn Watershed Overlay District ordinance currently requires a 300 foot horizontal setback from waterbodies within the watershed in sandy soils, more where flows exceed 2,000 gallons per day. The LAWPC should consider applying this setback around the entire lake, regardless of soil types. The Town of York, Maine requires all wastewater disposal systems shall be set back a minimum of 500 feet from the normal high water mark of a public water supply and 250 feet from all streams, including tributary streams. (Town of York, ME Zoning Ordinance. 2008). The County of York, VA prohibits septic tanks and drainfields within 500 feet of the required buffer strip to a tributary stream or reservoir (County of York, VA. Retrieved March 13, 2009). This will help with the long-term removal of phosphorus associated with wastewater.

Septic Inspections – The subsurface disposal rules do not require inspection and/or replacement of systems upon property transfer, however, 30-A MRSA § 4216 – Transfers of Shoreland Property outline some requirements within the shoreland zone (250 feet). LAWPC should consider requiring periodic inspection of existing septic systems in the entire watershed on a specific schedule. The cost of the inspection could be borne by the homeowner, and any identified malfunctions would be further documented by the local plumbing inspector and referred to the elected municipal officials for correction. This would alert the homeowner and the Town to a failure that may otherwise go unnoticed (Maine DEP, 2009).

Maintenance Requirements – Consider adding system maintenance requirements to the ordinance that requires residents to pump out their septic tanks on a specific schedule. The Association of New Jersey Environmental Commissions (ANJEC) has a model septic ordinance for operation and maintenance of on-site sewage disposal systems (ANJEC. Retrieved March 18, 2009).

Reserve Area – Require a reserve area for a replacement disposal field in the event of failure. This ensures that suitable soils remain undisturbed on the site to address future concerns.

Septic Density – The State requires 20,000 square feet of land for every 300 gallons per day of wastewater flow (equivalent to about a 3 bedroom home) and also requires that the flows of systems located within 100 feet of each other be added together to determine flow related setbacks. Increased flows increase the potential for pollution to reach groundwater. LAWPC should consider a requirement to limit the number of septic systems on a lot. This could be accomplished through more restrictive flow restrictions, for example, the Town of Hanover, Massachusetts prohibits individual sewage disposal systems with flows greater than 440 gallons per day on any one acre under one ownership (Town of Hanover, MA Zoning Bylaw, 2007) (LAWPC could match flows for a typical single-family home to the existing zoning within the watershed) or simply by requiring that a septic system must be located on the same lot as the building it serves.

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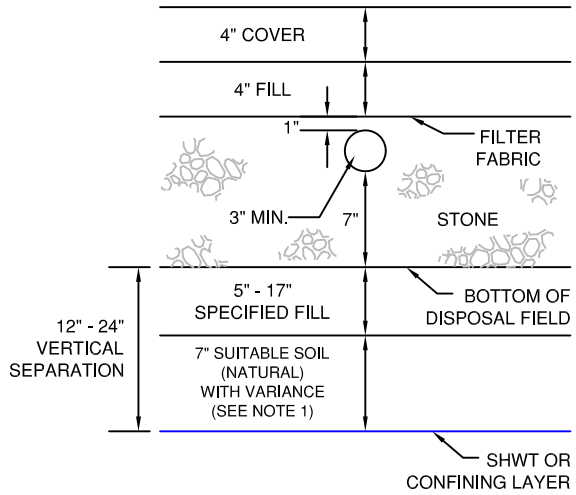
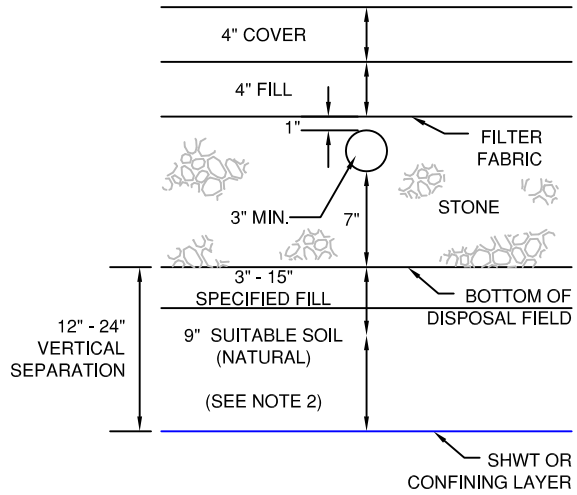


144 CMR 241
EXISTING

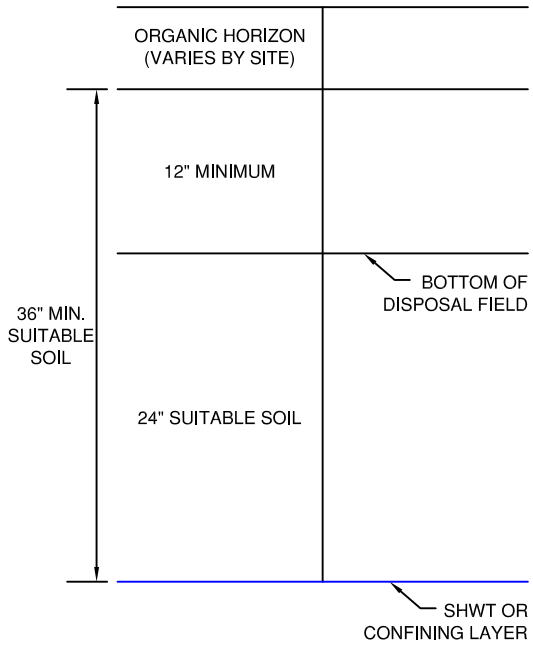
(TYPICAL STONE DISPOSAL FIELD)



144 CMR 241
PROPOSED

(TYPICAL STONE DISPOSAL FIELD)

SYSTEM MAY BE MOUNDED



LAKE AUBURN
EXISTING

DOES NOT ALLOW FOR MOUNDING

NOTES:
1. Regulations call for 12" of suitable soil outside of the shoreland area and 15" within. 7" of suitable soil may be allowed with a variance.
2. Proposed regulations call for 9" of suitable soil outside of shoreland area and 15" within. This eliminates the need for a variance outisde the shoreland area. 9" of suitable soil may be allowed within the shoreland area with a variance.

PROFILE

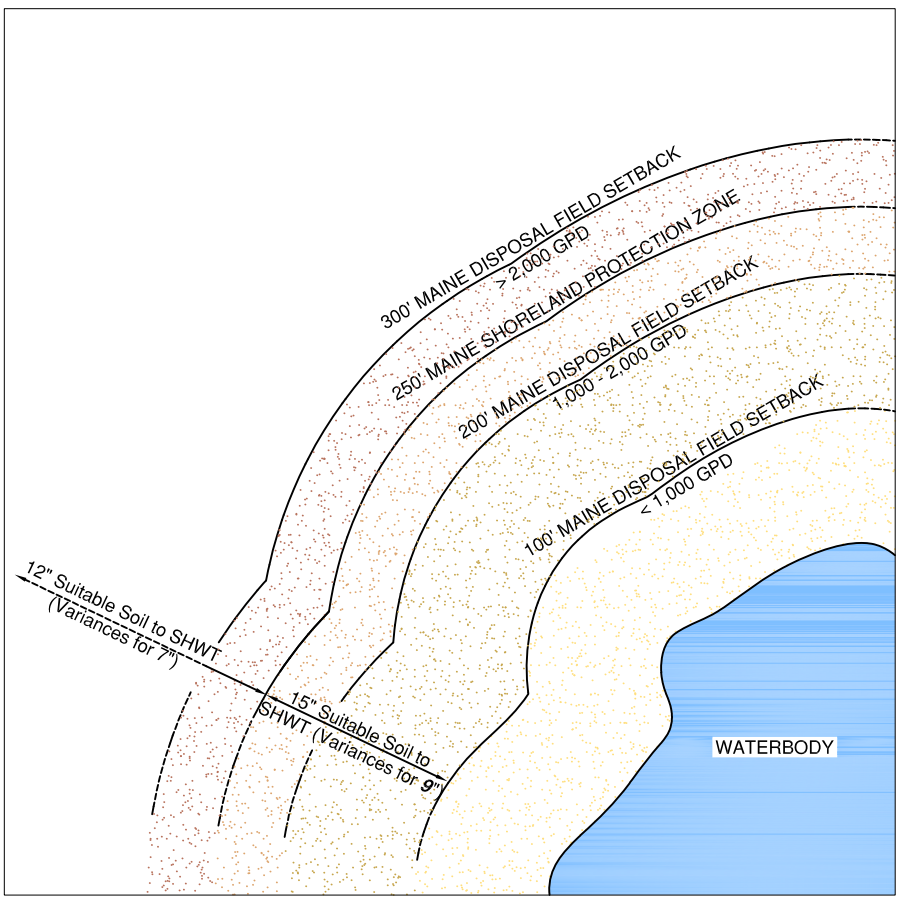
COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
MERRIMACK, NH

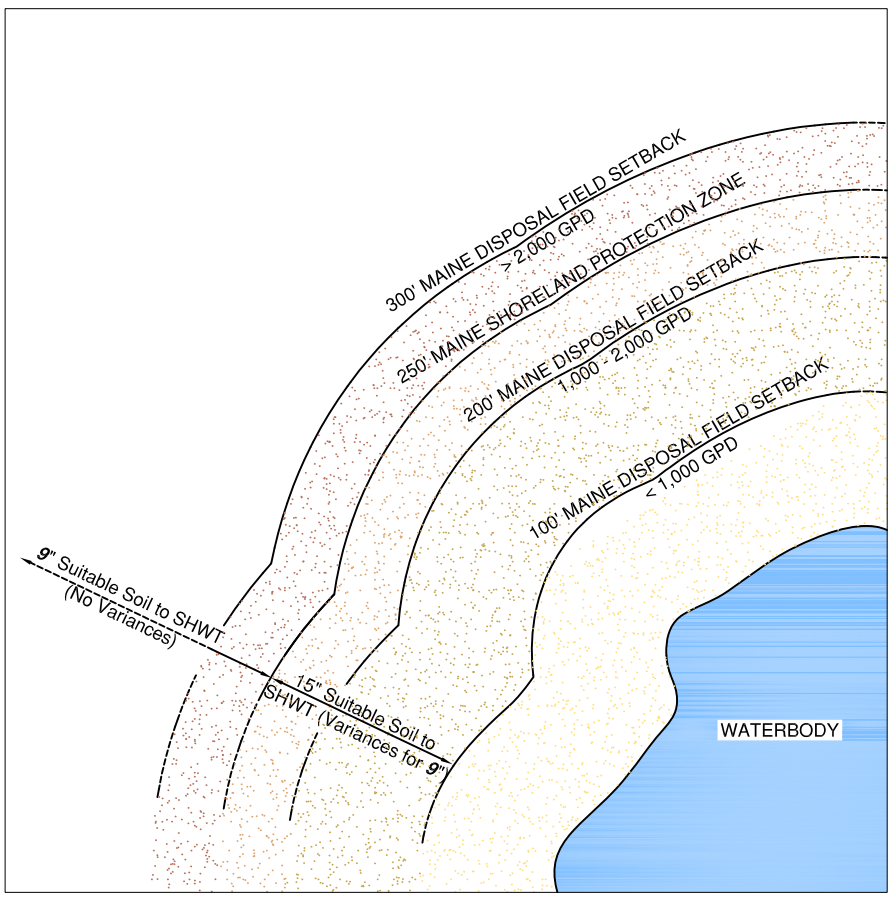
FIGURE 1

SUBSURFACE DISPOSAL SYSTEMS
DEPTH AND SUITABLE SOILS REQUIREMENTS
State of Maine and Lake Auburn Watershed, Southern Maine

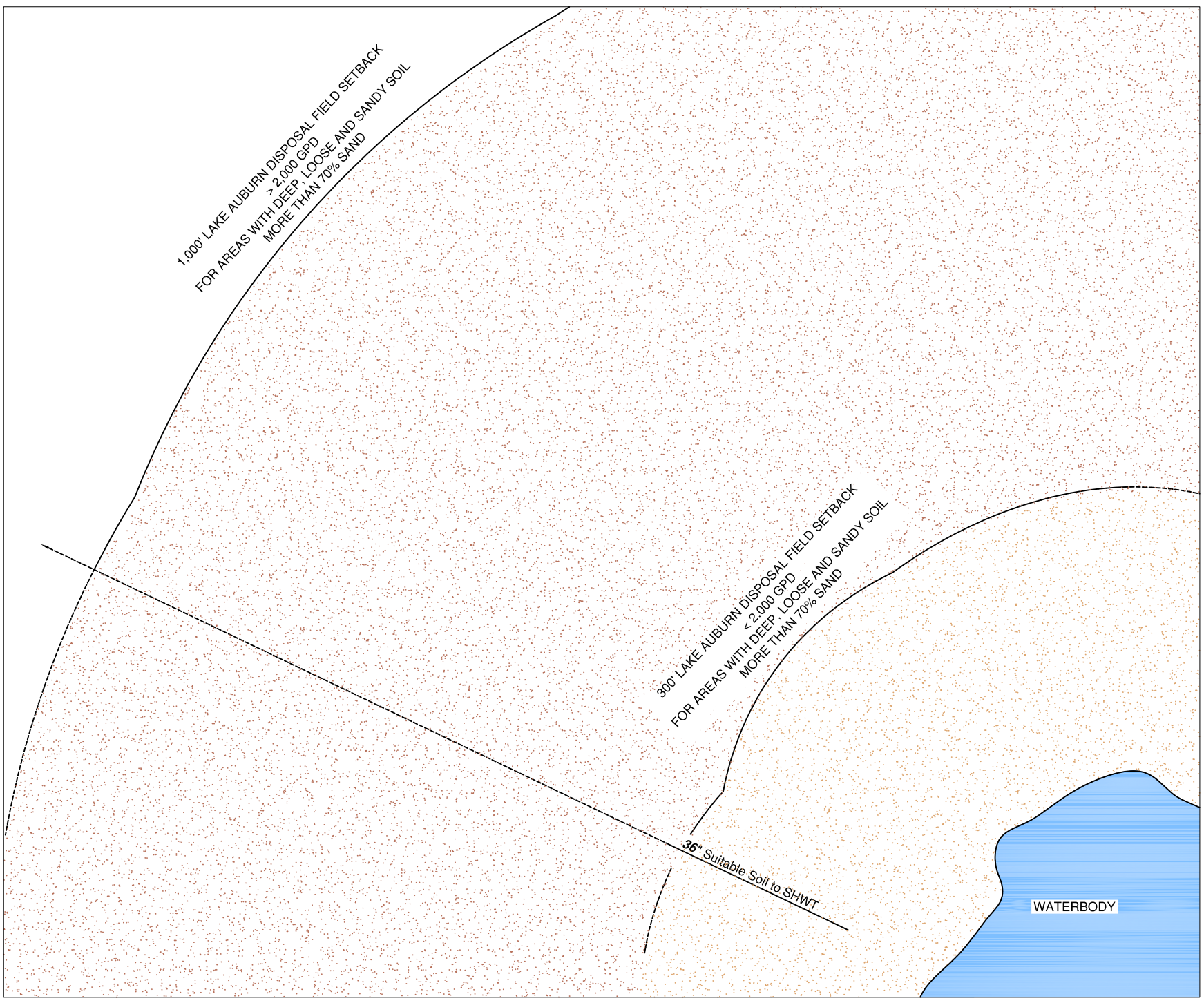
DRAFT - Do Not Cite or Quote



EXISTING 144 CMR 241
MAINE SUBSURFACE WASTEWATER DISPOSAL RULES



PROPOSED 144 CMR 241
MAINE SUBSURFACE WASTEWATER DISPOSAL RULES



EXISTING LAKE AUBURN OVERLAY DISTRICT
SUBSURFACE WASTEWATER DISPOSAL

PLANVIEW

COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

21 DEPOT STREET
MERRIMACK, NH

FIGURE 2
SUBSURFACE DISPOSAL SYSTEMS
SETBACK AND SUITABLE SOIL REQUIREMENTS
State of Maine and Lake Auburn Watershed, Southern Maine
DRAFT - Do Not Cite or Quote

Attachment A

EPA Document 816-K-06-005 –
The Multiple Barrier Approach to Public Health Protection

United States
Environmental Protection
Agency

The Multiple Barrier Approach to Public Health Protection

afe drinking water is essential to our physical health and to the economic health of our communities. However, drinking water is vulnerable to contamination from many potential threats. The 1996 Safe Drinking Water Act Amendments created a coordinated set of programs and requirements to help water systems make sure they have a safe supply of drinking water. These programs and requirements form a Multiple Barrier Approach that places technical and managerial barriers that help prevent contamination at the source, treatment, and tap to provide a safe supply of drinking water for consumers.

The barriers are:

Risk Prevention: Selecting and protecting the best source of water where possible or protecting a current source of water.

Risk Management: Using effective treatment technologies, properly designed and constructed facilities, and employing trained and certified operators to properly run system components.

Monitoring and Compliance: Detecting and fixing problems in the source and/or distribution system.

Individual Action: Providing customers with information on water quality and health effects so they are better informed about their water system.

By placing integrated barriers from the source to the consumer at the tap, water systems can help protect communities from the risk of contamination and waterborne disease. A successful multiple barrier approach includes:

Barriers between potential threats and the consumer.

For example:

- Source water protection activities such as identifying and reducing contamination in watersheds.
- Appropriate source water treatment.
- Properly trained, certified operators.
- Properly designed and constructed facilities.

Programs and activities to make sure the barriers are in place and operational.

For example:

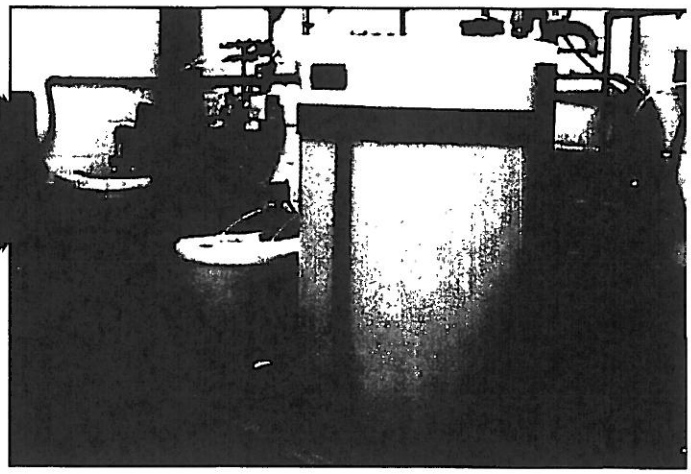
- Sanitary surveys to evaluate the adequacy of a water system's facilities for producing and distributing safe drinking water.
- Comprehensive Performance Evaluations to identify cost-effective improvements in system performance.
- Standards for the design and construction of a system's components.
- Continuing education and training of managers and certified operators.
- Strategic and emergency response planning to make sure a system is prepared for the future and for potential crises or disasters.

Did You Know?

Capacity development — the development of a system's technical, managerial, and financial ability to provide safe and adequate drinking water to its customers — is the foundation of a successful multiple barrier approach for any system.

Office of Water (4606M)
EPA 816-K-06-005
www.epa.gov/safewater
September 2006

Water Systems' Multiple Ba



Barrier #1: Risk Prevention

The first barrier in a water system's multiple barrier approach is risk prevention. Risk prevention focuses on the selection and protection of drinking water sources. Systems should be aware of potential contamination caused by agricultural drainage, urban runoff, organic materials, and other factors.

When selecting sources, systems should examine:

- The quality of the raw water (e.g., does it contain pathogens, chemicals, radionuclides, nitrates, or high turbidity?).
- The risk of contamination (e.g., will development encroach on the water source?).
- The ability of the supply to meet current and future needs.

Water systems, unless they are new systems, rarely have the opportunity to select their water source. But existing systems can and should take steps to protect their water sources, including:

- Identifying sources of contamination in watersheds and recharge areas.
- Identifying the conditions under which the risks increase.
- Developing and implementing source water protection strategies.

By properly selecting and protecting its water source, a system can reduce its need for and reliance on treatment and increase the reliability of its water quality and quantity.

The financial incentive for systems to prevent risks is significant. It is almost always more cost-effective for a water system to protect its source water from contamination than to remove or inactivate contamination during treatment.

Barrier #2: Risk Management

Risk management barriers focus on the protection provided by water treatment and system operations. Public water systems traditionally have relied on treatment to prevent waterborne disease. Treatment continues tc play a central role in protecting public health.

Water treatment:

- Removes and inactivates contaminants present in source water.
- Leads to improved finished water quality.

No single treatment technology or process can solve every water quality problem, so a water system should consider using a combination of treatment technologies and processes if necessary.

To provide adequate protection of public health, a water system:

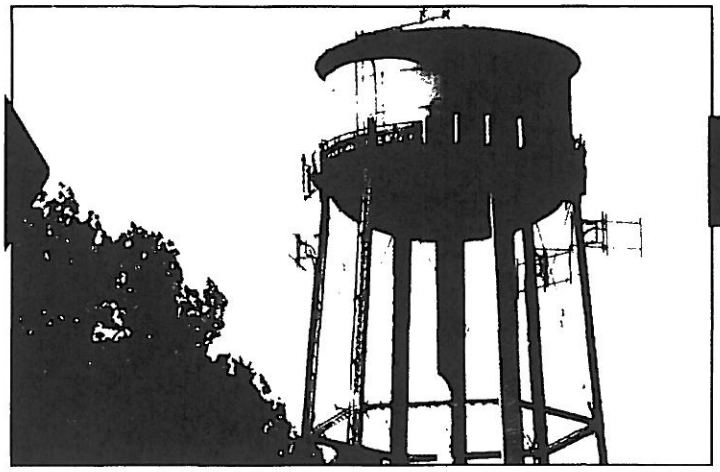
- Must meet its state's minimum design and construction standards.
- Should develop asset management plans that help provide sound infrastructure.
- Must meet federal and state drinking water standards.

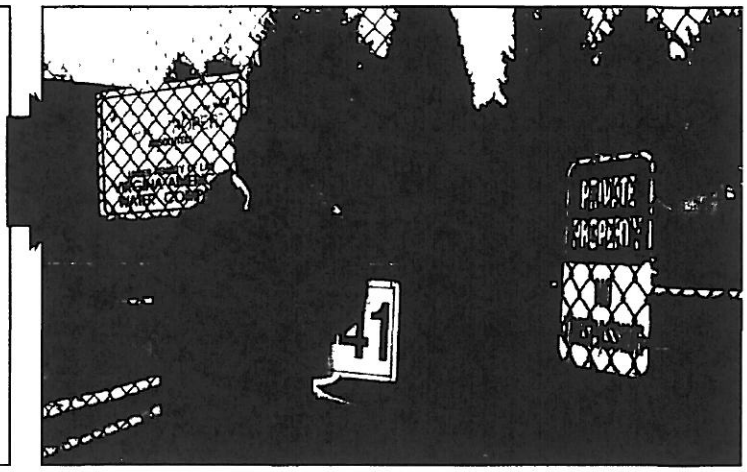
In addition to using the appropriate treatment, water systems should make sure that their operators are properly certified and know how to apply treatment concepts to the specific circumstances facing their system. Water systems should also test the treatment process that they are using to be certain that the treatment is working correctly.

The risk management barrier also includes developing and putting in place appropriate security arrangements and comprehensive plans to respond tc emergencies, thus reducing the risk of serious consequences from a security breach or other emergency.

A wide range of financial assistance and incentives are available to help systems fund upgrades or replacement of their treatment components. Contact information for some key providers of financial assistance is listed on the last page of this brochure.

riers to Protect Public Health





Barrier #3: Monitoring and Compliance

Under the monitoring and compliance barrier, systems aim to detect and fix problems in the source and/or distribution system as early as possible. They accomplish this by collecting information about:

- The presence of contaminants.
- The effectiveness of current treatment processes.
- Any deterioration in the quality of source or treated water.

Monitoring the quality of water is very important in the distribution system, as well as throughout the entire water system. Even if water from an extremely clean source is adequately treated, breakdowns in the distribution system can lead to waterborne illnesses. In particular, the contamination of treated water can result from:

- Line breaks.
- Inadequate water pressure.
- Deficiencies in storage tanks.
- Inadequate separation of water supply lines and sewers.

Part of the strategy for this barrier should include a cross-connection detection and control program as well as efforts to make sure that all distribution system components are properly sized and maintained. Water systems must also monitor water in the distribution system for the formation of byproducts from disinfection and for the leaching of lead and copper from household plumbing.

Monitoring programs should be developed around the needs and characteristics of individual water systems, and they should comply with all regulatory requirements. The monitoring and compliance barrier helps a system maintain the physical integrity of its components and make adjustments as necessary to provide a consistent, safe supply of water.

From a financial perspective, operators who have data on the performance and condition of their system's components (as part of an asset management plan) can increase the useful life of system components and quickly identify and respond to small problems before they become large and expensive.

Barrier #4: Individual Action

Consumer awareness and participation are key components in the multiple barrier approach.

A community water system is required to prepare and provide to their customers, at least annually, Consumer Confidence Reports (Annual Water Quality Reports) that discuss:

- The condition of the system's source water.
- The level of contaminants in the system's drinking water.

The reports are a way to raise consumer awareness about drinking water, and they can be used as a tool to encourage dialogue between consumers and the water system.

Water systems are also required to notify the public of any violations of national drinking water standards. Public notification makes sure that:

- Consumers are informed of any health risks in a timely manner.
- Water systems build trust with consumers by sharing information.

Beyond information sharing, systems can benefit greatly from involving the public in a variety of activities. For example:

- Systems can further their source water protection efforts by helping the public form watershed associations.
- Systems can encourage the public to notice and report activities that could represent contamination or sabotage threats to the water system.

Informed and involved consumers can become advocates for improvements in their water system's operations. Public education and participation can also help consumers become more aware of the true cost and value of water.

From a financial perspective, customers who have a better understanding of their water system, the true cost and value of water, and the role they play will be more likely to support rate increases and bond issues needed to fund multiple barrier approach activities.

Sources of additional information

For additional information, contact your state drinking water program.

General information

- Safe Drinking Water Hotline - (800) 426-4791
- EPA's Office of Ground Water and Drinking Water - http://www.epa.gov/safewater
- EPA's Capacity Development Program - http://www.epa.gov/safewater/smallsys/small.htm

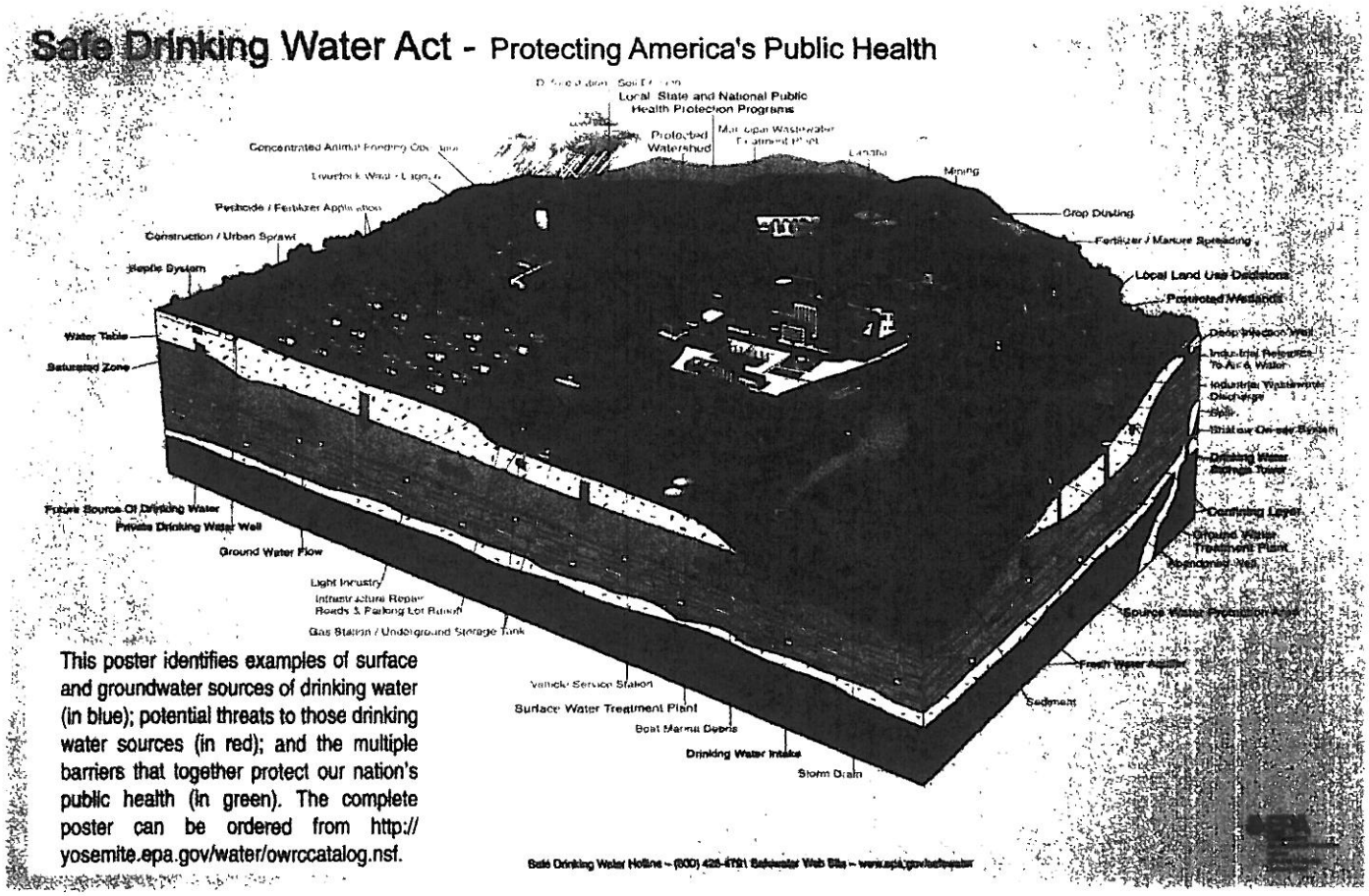
Technical Assistance Providers

- National Rural Water Association (NRWA) - http://www.nrwa.org
- Rural Community Assistance Partnership (RCAP) - http://www.rcap.org
- National Environmental Services Center (NESC) - http://www.nesc.wvu.edu
- Technology Assistance Centers (TACs) - http://www.tacnet.info

Financial Assistance Providers

There are many sources of financial assistance and incentives to help systems fund multiple barrier approach programs and activities. Some of the key providers of financial assistance are:

- Drinking Water State Revolving Fund (DWSRF) - http://www.epa.gov/safewater/dwsrf.html
- Rural Development Water and Wastewater Loan and Grant Program - http://www.usda.gov/rus/water/states/usamap.htm
- Community Development Block Grants (CDBG) - http://www.hud.gov/offices/cpd/communitydevelopment/programs/



Appendix D
Model Septic Ordinance for O&M

This model ordinance regulates only the operation and maintenance of on-site sewage disposal systems, not the siting and construction of such systems. (See Commentary)**

AN ORDINANCE TO AMEND THE CODE OF THE BOARD OF HEALTH OF THE (INSERT NAME OF JURISDICTION) TO ESTABLISH REQUIREMENTS FOR THE OPERATION AND MAINTENANCE OF ON-SITE SEWAGE DISPOSAL SYSTEMS.

BE IT ORDAINED by the Board of Health of the (INSERT NAME OF JURISDICTION) in the County of (Insert Name of County) and State of New Jersey as follows:

SECTION ONE

A. FINDINGS

It is found and declared that:

1. Individual and non-individual on-site subsurface sewage disposal systems are in use within the (insert name of jurisdiction).
2. Existing subsurface sewage disposal systems have malfunctioned even when the systems have been designed, constructed, and sited in accordance with applicable standards, largely due to lack of proper system management or improper operation and maintenance. These malfunctions have been shown to adversely affect public health and welfare and the environment. Such systems constitute a potential source of pollution of ground and surface waters, contamination of potable water supplies, foul odors, nuisance problems and other hazards to public health.
3. It is determined to be in the interest of public health, safety and welfare to establish provisions to regulate the management of such systems to protect the public against system failures and resultant pollution.
4. The licensing provisions contained in this Ordinance are necessary to protect the public health safety and welfare and it is therefore necessary to exceed the provisions contained in N.J.A.C. 7:9A-1 et seq. This is hereby declared to be a "special ordinance" in accordance with N.J.A.C. 7:9A-3.1(b) and shall be forwarded to the New Jersey Department of Environmental Protection within 10 days of adoption.

OR

A. PURPOSE.

In addition to the purposes set forth in N.J.A.C. 7:9A-1.1., it is the purpose of this ordinance:

1. To establish a management program for individual and non-individual subsurface sewage disposal systems in the (insert name of jurisdiction) in order to ensure the proper operation and maintenance of such systems. This ordinance requires existing, new and proposed individual and non-individual subsurface sewage disposal systems to be pumped out at least once every three years in order to minimize future malfunctions of such systems.
2. To regulate individual and non-individual subsurface sewage disposal systems in the program area in such a way as to protect public health and welfare and the environment, and to provide for a means of educating owners/operators, as defined herein, in the characteristics of such systems and the proper procedures for altering, operating and maintaining them.
3. To develop a management program to maintain records and manage systems in the program area.
4. To promote and assure the proper management and maintenance of individual and non-individual sewage disposal systems through time.

SECTION TWO. TITLE

This Ordinance shall be known as the Subsurface Sewage Disposal System Management Ordinance of the (insert name of jurisdiction.)

SECTION THREE. DEFINITIONS

All definitions given in Subchapter 2 (N.J.A.C. 7:9A-2.1 et. seq.) of the New Jersey Department of Environmental Protection (NJDEP) Standards for the Construction of Individual Subsurface Sewage Disposal Systems, N.J.A.C, 7:9A-1.1 et seq., and any amendments thereto ("NJDEP Regulations") are hereby incorporated into this article, with the following additions:

ACTIVE USE- For initial licenses, this term shall mean: "The use or direction of waste water to a system after the adoption date of this ordinance." For renewal licenses, this term shall mean: The use or direction of waste water to a system at any time during the period of the license."

BOARD OF HEALTH- The Board of Health of the (insert name of jurisdiction)

EDUCATION PROGRAM - An educational program prepared and administered by the Board of Health regarding the fundamentals of individual and non-individual subsurface sewage disposal systems and the proper procedures for the operation and maintenance of such systems. The educational program shall be deemed to be in accordance with N.J.A.C. 7:9A-3.14.)

ENFORCING OFFICIAL - The (Insert name of officer) of the (insert jurisdiction) or his designee.

INDIVIDUAL SUBSURFACE SEWAGE DISPOSAL SYSTEM- An individual subsurface sewage disposal system, as defined at N.J.A.C. 7:9A- 2.1, serving a single family detached residential housing unit.

LICENSED SEPTIC SLUDGE REMOVAL OPERATOR - Any person, firm or corporation which has been duly examined by the enforcing official and found qualified to pump out an individual or non-individual subsurface sewage disposal system, and who has been issued a license.
MANAGEMENT DISTRICT - (This definition is necessary if the ordinance is to be applied only to a portion of a jurisdiction. The definition must be developed locally and specifically describe the geographic area to be subject to the ordinance.)
NON-INDIVIDUAL SUBSURFACE SEWAGE DISPOSAL SYSTEM - An on-site subsurface sewage disposal system serving a property other than a single family home. Such systems include but are not limited to those systems defined in N.J.A.C. 7:9A-1.8(c)2. Typical examples include but are not limited to: commercial buildings, restaurants, food establishments, commercial/residential mixed uses, and systems servicing multiple units.
OPERATOR'S LICENSE - A license issued to an applicant pursuant to this ordinance for the operation of an individual or non-individual subsurface sewage disposal system.
OWNER OR OPERATOR – The person who owns or leases the realty upon which an individual or non-individual subsurface sewage disposal system is located and/or the person who uses or operates said system. The owner of the reality and the operator of the system, if different, are jointly and severally liable for the obligations imposed by this ordinance.
PLOT PLAN – A sketch drawn by the owner/operator, or agent on their behalf, showing the type (if known) and location of the individual or non-individual subsurface sewage disposal system servicing the property, as well as the location and type of any on–site water supply. All plots shall be drawn to scale and list the dimensions used.
RETAIL FOOD ESTABLISHMENT - Any fixed or mobile restaurant; coffee shop; cafeteria; short order cafe; luncheonette; grill; tearoom; sandwich shop; soda fountain; tavern; bar; cocktail lounge; night club; roadside stand; industrial feeding establishment; private, public, or nonprofit organization, institution, or group preparing, storing or serving food; catering kitchen; commissary; box lunch establishment; retail bakery; meat market; delicatessen; grocery store; public food market, or any similar place in which food or drink is prepared for retail sale or service on the premises or elsewhere, and any other retail eating or drinking establishment or operation where food is served, handled or provided for the public with or without charge.
SYSTEM - An individual or non-individual subsurface sewage disposal system, including all of the component parts thereof.

SECTION FOUR. SCOPE, APPLICABILITY AND EXEMPTIONS

A. **SCOPE**. The owner and/or occupant of any realty improvement serviced by an individual or non-individual on–site subsurface sewage disposal system located in the (Option One - Management District) (Option Two - insert name of jurisdiction) shall be subject to all of the requirements of this chapter.
B. **APPLICABILITY.** No person within the (insert name of jurisdiction) area shall operate an individual or non-individual subsurface sewage disposal system unless such construction, installation, alteration, maintenance or operation is in accordance with all applicable sanitary regulations and this ordinance.
C. **EXEMPTIONS.** Any system not in active use shall be exempted from this Ordinance. The Board of Health may require an owner or operator of a system seeking exemption under this section to submit proof in the form acceptable to the Board so as to qualify for this exemption.

SECTION FIVE. LICENSE TO OPERATE

A. **REQUIREMENT FOR LICENSE**: On and after (insert effective date) no owner or occupant of a property in the (insert name of jurisdiction) upon which an individual or non-individual subsurface sewage disposal system is located shall use or operate the system unless a currently valid license to operate the system has been issued by the Board of Health in accordance with the schedule herein to the owner of the property on which the system is located.

1. The Board of Health or its designee may issue a license to operate and educational information relative to the proper operation and maintenance practices (pursuant to N.J.A.C. 7:9A-3.14) to the owner and occupant of a property upon one or more of the following events:
   a. Issuance of a certificate of compliance for a new system.
   b. Issuance of a certificate of compliance for the alteration of a system
   c. Upon the sale or transfer of a premises.
   d. For all existing individual and non-individual sewerage disposal systems in accordance with the following schedule

      Option 1- Immediate effective date for all systems
      Option 2- Deferred effective date for all systems
      Option 3- Phased in date for existing systems
2. All licenses issued pursuant to this section shall be on a form provided by the Board of Health. Once issued, a license shall be transferable upon change of ownership or occupancy of the premises for which the license has been issued. A fee as provided in section eleven of this ordinance thereof shall accompany each application for a license or renewal. The initial application for a license shall include a plot plan showing the location of the septic system (both the tank and

the disposal area) and of any private water source on the property. The plot plan shall also include the general location, if known, of any wells, and septic systems on adjoining properties.

B. EXPIRATION/RENEWAL The license to operate shall expire three (3) years after issuance. The Board of Health shall notify the licensee or its designee at least (INSERT REASONABLE TIME) before the license expires and shall be directed to apply for a renewal of the license. The renewal notice shall include educational materials relative to the proper operation and maintenance practice for such systems in accordance with N.J.A.C. 7:9A-3.14.

1. Requirements for Renewal: The Board of Health or its designee shall not renew the license unless the licensee has submitted the following to the Board of Health or its designee:

JURISDICTIONS SHOULD CHOOSE EITHER OPTION 1 OR OPTION 2

OPTION 1

a. Evidence that the septic tank (or in the case of an alternate system, the comparable component of such system) has been pumped by a licensed septic sludge removal operator as required by Section Seven of this Ordinance; or
b. Submission of a Septic System Inspection Report on a form approved by the Board of Health indicating that the system has been maintained, is not in need of pumping, and is functioning in conformance with the requirements of this chapter. Said form shall be prepared, completed and certified by:

i) A staff member of the Board of Health;
ii) A licensed septic installer;
iii) A NJDEP registered inspector;
iv) A NJDEP registered waste hauler;
v) A licensed professional engineer;
vi) A licensed health officer or sanitarian;
vii) (Insert local option if, any); or
viii) Other person acceptable to the Board of Health.

Any such inspection under this section, shall include but not be limited to the following:

i) A complete walkover of the septic field;
ii) Measurement of the effluent in inspection ports, (if any) and a reading of the groundwater monitoring port when such ports were included in the original septic design; and
iii) An inspection of baffles and internal integrity of the tank.

OPTION 2

Submission of a Septic Sysem Inspection Report only as required in ***OPTION 1*** *on this page.*
(Section Five B1b.)

Any such inspection shall be conducted in accordance with any NJDEP approved protocol, guidance or regulations.

If the inspection indicates that a pumpout of the tank or other maintenance, alteration, or repair of the system is necessary, the Board of Health shall issue a notice of pumping, alteration or repair. Following pumpout or other maintenance, alteration or repair of the system, the owner /operator shall submit to the Board of Health a completed alteration/pumpout report prepared and signed by the person performing the required work.

No person shall test an individual or non-individual subsurface sewage disposal system in a manner that will adversely affect the functioning of the system. Hydraulic loading shall not be applied in excess of the design flow capacity. All solids shall have been removed from the septic tank and/or grease trap prior to testing unless the hydraulic loading is applied at a point that will bypass the septic tank and/or grease trap.

2. Renewal Term: Any license renewed under section B.1.a (Actual pumping) shall be renewed for a period of three years Any license renewed under section B.1.b. (Inspection) shall be renewed for period of (insert term) years.
3. As a condition precedent to a license renewal, the owner/operator shall pay the fee required by section eleven herein.

C. SUSPENSION OF LICENSE: The Board of Health or its designee may suspend or revoke the license to operate in the following circumstances:

1. It has been determined that the system is malfunctioning based upon criteria provided for in N.J.A.C. 7:9A-3.4(a) and

the licensee fails to take steps to correct said malfunction as directed by the Board of Health or its designee;

2. The owner or occupant of the premises served by the system violates any provision of this chapter with respect to operation and maintenance of the system; or
3. The owner or occupant of the premises served by the system denies the right of entry to the Board of Health or its designee, or to the New Jersey Department of Environmental Protection (NJDEP), as required in N.J.A.C. 7:9A-3.19, or in any way interferes with the administration or enforcement of this ordinance.

D. MODIFIED TERM OF LICENSE: The Board of Health may on its own motion, upon notice and opportunity to the property owner or operator for a hearing, or upon application of a property owner or system operator, alter the time period of a license to operate.The Board of Health may consider the following factors in determining that a more frequent licensing renewal or pumping/inspection schedule may be necessary:

1. Limited size of the septic tank or disposal field;
2. The fact that the existing system may be a cesspool;
3. The age of the system;
4. Past history of malfunction or other non-compliance;
5. Location of the existing system in a flood hazard, wetland area, wetland transition zone or other environmentally sensitive area as defined in (insert reference);
6. Proximity of the system to a well or water body.

E. SPECIAL LICENSING PROVISIONS FOR RETAIL FOOD HANDLING ESTABLISHMENTS:

The license to operate for a retail food handling estabishment shall expire one year after issuance or one year from the date of the documented pumpout, whichever comes first. The owner of said establishment shall have the right to apply to the Board of Health for a longer license renewal period, but in no case shall the license renewal period exceed three years. In considering any such application the Board of Health may consider the establishment's demonstrated compliance history of with management of the system.

SECTION SIX . STANDARDS ON THE USE OF SUBSURFACE SEWAGE DISPOSAL SYSTEMS

A. GENERAL

1. The subsurface sewage disposal system shall be used only for the disposal of wastes of the type and origin provided for in the approved engineering design. No permanent or temporary connection shall be made to any source of wastes, waste water or clean water other than those plumbing fixtures which are normally present within the type of facility indicated in the approved engineering design.
2. Drainage from basement floors, footings or roofs shall not enter the sewage disposal system and shall be diverted away from the area of the disposal field.
3. As set forth in N.J.S.A. 58:10A-17, no person shall use or introduce or cause any other person to use or introduce into any sewage water disposal system any sewage system cleaner containing any restricted chemical material.
4. Disposal of materials containing toxic substances into a subsurface sewage disposal system is prohibited. Materials containing toxic substances include, but are not limited to, waste oil (other than cooking oil), oil based or acrylic paints, varnishes, photographic solutions, pesticides, insecticides, paint thinners, organic solvents or degreasers and drain openers.
5. Inert or non-biodegradable substances should not be disposed of in the subsurface sewage disposal system. Such substances include, but are not limited to, disposable diapers containing plastic, cat box litter, coffee grounds, cigarette filters, sanitary napkins, facial tissues and wet-strength paper towels.
6. Large quantities of cooking greases or fats shall not be discharged into systems not equipped with a grease trap designed and constructed as prescribed in N.J.A.C.7:9A-8.1.
7. Major plumbing leaks shall be repaired promptly to prevent hydraulic overloading of the system.
8. Vehicle traffic and vehicular parking shall be kept away from the aspects of the system, unless the system has been specifically designed to support vehicular traffic.

B. DISPOSAL FIELD MAINTENANCE

1. The area of the disposal field shall be kept free of encroachments from decks, pools, sprinkler systems, driveways, patios, accessory buildings, additions to the main building and trees or shrubbery whose roots may cause clogging of any part of the system
2. Grading shall be maintained in a condition that will promote run-off of rainwater and prevent ponding.
3. All drainage from roofs, footing drains, ditches or swales shall be diverted away from the disposal field.
4. Vegetation shall be maintained to prevent soil erosion.
5. Vehicle traffic and vehicular parking shall be kept away from the area of the disposal field, unless the disposal field has been specifically designed to support vehicular traffic.

C. ABANDONED SYSTEMS

1. When it is necessary to abandon a system or components of a system, all septic tanks, dosing tanks, seepage pits, dry wells and cesspools which are to be abandoned shall be emptied of wastes and removed or filled completely with sand, gravel, stones or soil material in a manner which is acceptable to the Board of Health or its designee.
2. Except when done as part of or in conjunction with an alteration, a permit must be obtained from the Board of Health prior to abandoning a septic system or component of a septic system.

D. ADDITIONAL INSPECTION AND MAINTENANCE REQUIREMENTS FOR SYSTEMS WITH GREASE TRAPS

1. Grease traps shall be inspected and cleaned out at a frequency adequate to prevent the volume of grease from exceeding the grease retention capacity. Grease shall be removed whenever seventy-five percent (75%) of the grease retention capacity has been reached.
2 Pumping of grease traps shall be performed by a solid waste hauler registered with the NJDEP in accordance with the requirements of N.J.A.C. 7:26-3.1
3. Equipment used in the pumping of grease traps shall meet the following requirements:
   a. Mobile tanks shall be securely mounted on trucks or trailers, shall be watertight and provided with a leak-proof cover and shall be vented to permit the escape of gases but not the liquid or solid contents of the tank.
   b. Pumps and hoses shall be maintained and operated in a condition that will prevent the leakage of sewage.
   c. Equipment shall be available to permit accurate measurement of the volume of grease in relation to the grease retention capacity of the grease trap.
   d. Pumping of grease traps shall be conducted in such a manner that the entire contents of the grease trap including both liquids and solids are removed.
   e. Pumping shall be carried out in a manner that will prevent spillage of sewage onto the ground. If any spillage occurs, the solid portion shall be immediately removed and disposed of in a sanitary manner and the area of the spill shall be disinfected using a suitable chlorine-bearing compound.
   f. Grease and other waste materials removed from grease traps shall be disposed of in accordance with the requirements of the Statewide Sludge Management Plan adopted pursuant to N.J.S.A. 13:1E-1 et seq. and N.J.S.A. 7:11A-1 et seq., as well as any other applicable State or local rules, regulations, ordinances or directives.

E. MAINTENANCE OF DOSING TANKS

1. Dosing tanks and associated pumps, siphons, switches, alarms, electrical connections and wiring shall be maintained in proper working order.
2. Any solids that accumulate in the dosing tank shall be removed and disposed of in a sanitary manner.

SECTION SEVEN. REMOVAL OF SEPTIC TANK SLUDGE

A. Any person, partnership, firm or corporation who empties, relieves or pumps out all or a portion of an individual or non-individual sewage disposal system within the (insert jurisdiction) shall first apply to the Board of Health to become a licensed septic sludge removal operator. The applicant shall have the following qualifications: (Insert qualifications.) Any such license shall be for a term of (insert time period) and shall be subject to the payment of a fee as provided in section eleven of this ordinance.

B. Prior to emptying, relieving or pumping out all or a portion of any individual or non-individual subsurface sewage disposal system within the (insert name of jurisdiction), the licensed septic sludge removal operator shall obtain a septic sludge removal permit from the Board of Health.

C. The septic sludge removal operator shall complete all information on the septic sludge removal permit and deliver one (1) copy to the property owner and one copy to the Board of Health within 72 hours of the time that the individual or non-individual sewage disposal system is pumped. Failure to deliver said report within the required time frame shall be considered to be a violation of this ordinance.

D. In addition to the license required under section a above, the pumping of septic tanks shall be performed by a solid waste hauler registered with the NJDEP in accordance with the requirements of N.J.A.C. 7:26-3.c.

E. The Board of Health may suspend or refuse to renew the license of any septic sludge removal operator who fails to comply with this ordinance.

F. Equipment used in the pumping of septic tanks shall meet the following requirements:
   1. Mobile tanks shall be securely mounted on trucks or trailers, shall be watertight and provided with a leak-proof cover and shall be vented to permit the escape of gases but not the liquid or solid contents of the tank.
   2. Pumps and hoses shall be maintained and operated in a condition that will prevent the leakage of sewage.
   3. Equipment shall be available to permit the accurate measurement of the sludge and scum levels in relation to the bottom of the outlet baffle.

G. Pumping of septic tanks shall be conducted in such a manner that the entire contents of the septic tank including both

liquids and solids are removed.

H. Pumping shall be carried out in a manner that will prevent spillage of sewage onto the ground. If any spillage occurs, the solid portion shall be immediately removed and disposed of in a sanitary manner and the area of the spill shall be disinfected using a suitable chlorine-bearing compound.

I. Septage shall be disposed of at a sewage treatment plant designated in accordance with District and/or State Solid Waste Management Plans pursuant to the Statewide Sludge Management Plan adopted pursuant to N.J.S.A. 13:1E-1 et seq. and N.J.S.A 58:IA-1 et seq.

SECTION EIGHT. APPEAL TO BOARD OF HEALTH

Any person aggrieved by any decision of a designee of the Board of Health made pursuant to this chapter shall have the right to appeal that decision to the Board of Health. Any aggrieved person seeking a hearing under this section shall make application to the Board in writing within 30 days of the decision to be appealed. The Board of Health shall schedule the matter for a hearing within 45 days thereafter. The hearing shall be conducted at a meeting held pursuant to the Open Public Meetings Act.

SECTION NINE. ENFORCEMENT

A. NUISANCES TO BE CORRECTED

1. Any on-site sewage disposal system or component thereof that is found to be malfunctioning (as defined in N.J.A.C. 7:9A-2.1 and 3.4) shall constitute a nuisance and shall be repaired, modified or replaced pursuant to an order of the Board of Health or its designee to correct the condition caused by the malfunction. Alterations shall be performed in accordance with "Standards for the Construction of Individual Subsurface Sewage Disposal Systems" as adopted and implemented by the Board of Health by virtue of this Code and any amendments thereto.
2. Any individual or non-individual subsurface sewage disposal system which has not been maintained in accordance with N.J.A.C. 7:9A:12.3, Septic Tank Maintenance, is hereby declared a nuisance.
3. Any individual or non-individual subsurface sewage disposal system which is constructed, installed, altered, operated or maintained in violation of this section, the DEP Regulations, any rule or regulation promulgated pursuant to this ordinance or any permit, certificate or license issued pursuant to this ordinance is hereby declared to be a nuisance.
4. In addition the powers provided for in N.J.A.C. 7:9A-1.1 et seq., the Board of Health retains its authority to abate any nuisance in accordance with the provisions of N.J.S.A. 26:3-45 et.seq.

B. MALFUNCTIONING SUBSURFACE SEWAGE DISPOSAL SYSTEM: INSPECTIONS OF SYSTEM; REVOCATION OF LICENSE

1. The Board of Health shall have the right to inspect any system which shows evidence of any malfunction. Such evidence may include, but not be limited to, foul odors, leakage to ground surface, or soggy ground over system. Water and/or soil samples may be taken to confirm the existence of a malfunctioning system.
2. The Board of Health may require that any malfunctioning system be corrected by servicing or by replacement or alteration of the system.
3. Until any necessary replacement or alteration of a system has been accomplished, the Board of Health may require pumping and the removal of the entire contents of the septic tank for the system (both liquids and solids) at intervals specified by the Board.
4. No provision to this Ordinance shall be interpreted as precluding the Board of Health from revoking a license issued by the Board for the operation of a system in the event that the Board shall determine that such action is necessary and appropriate for the enforcement of this Ordinance. Any such revocation shall be upon Notice to the owner.operator, with an opportunity to comment or appeal.

SECTION TEN. RIGHT OF ENTRY

In furtherance of the rights granted to the Board of Health in N.J.S.A. 26:3-45 et seq. and N.J.A.C. 7:9-3.19, the (insert name of enforcing official) or his designee, upon presentation of identification, shall have the right to enter upon property where an individual or non-individual subsurface sewage disposal system is located for the purpose of observation, inspection, monitoring and/or sampling of the on-site sewage disposal system. 'This authority is exercised by virtue of N.J.S.A. 26:3-31 as a necessary and reasonable method of furthering the duties of the Board of Health as enumerated therein.

SECTION ELEVEN. FEES

A. Initial License
B...Renewal License
C...Board of Health Inspection at time of license renewal

D.. Septic Sludge Removal Operator
E. Septic Sludge Removal Ppermit

SECTION TWELVE. VIOLATIONS AND PENALTIES

A. A person who violates any provision of this article, or any term or condition of any certificate or license issued hereunder, shall be liable for one or more of the following penalties [N.J.S.A. 40:69A-29(b)].
   1. A fine of not less than one hundred dollars ($100.00) nor more than $1,000.
   2. A period of community service not to exceed 90 days.

B. Each separate day and each violation of any provision or this article, any term or condition of any certificate or license or any notice or order issued by the Board of Health shall constitute a separate and distinct violation under this ordinance.
C. Nothing in this section shall be construed as limiting the remedies of the Board of Health for violation of this article. The Board of Health may proceed under any other remedy available at law or in equity for any violation of this article or any term or condition of any certificate or license issued by the Board or Health or for any failure to comply with any notice or order issued by the Board of Health or its enforcement official under this ordinance.

SECTION THIRTEEN. REPEAL OF INCONSISTENT ORDINANCES.

All ordinances, codes or parts of same inconsistent with any of the provisions of this ordinance are hereby repealed to the extent of such inconsistency

SECTION FOURTEEN. EFFECTIVE DATE

This ordinance shall take effect thirty (30) days after adoption and publication of a Notice of Adoption in accordance with New Jersey law.

SECTION FIFTEEN. SEVERABILITY

In the event that any provision of this Ordinance or its application to any person is held invalid for any reason, such invalidity shall not affect any other provision of this Ordinance and to this end, the provisions of this Ordinance are severable.

****Commentary -In consultation with NJDEP and an attorney, ANJEC developed this model ordinance. It regulates only the operation and maintenance of on-site sewage disposal systems, not the siting and construction of such systems.**

Appendix E
Stormwater BMP Information (Filterra Systems, StormTreat Systems, Contech Filtration)

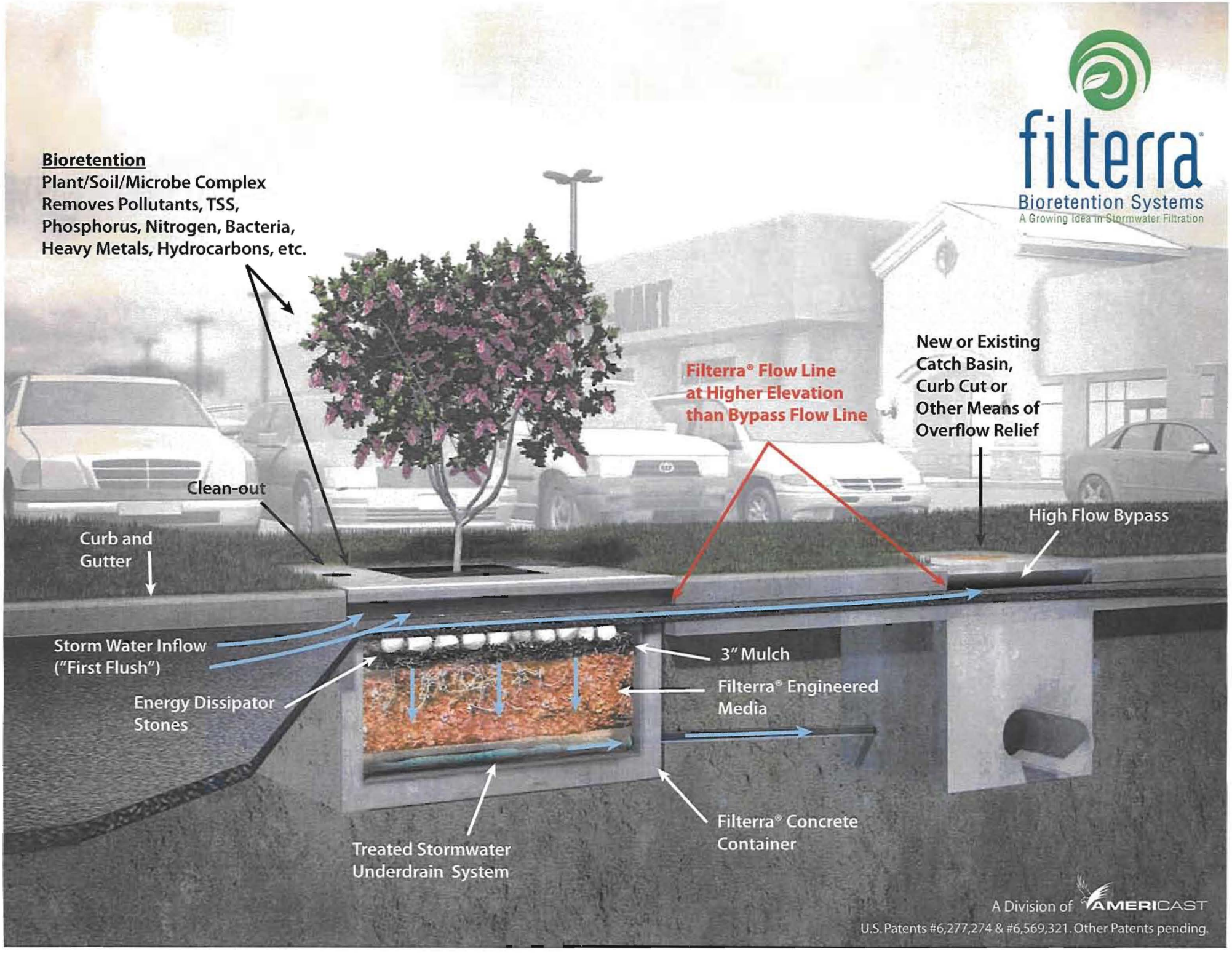
Filterra Systems

About Filterra Bioretention Systems

The Filterra Bioretention Systems was developed by its parent company, Americast, in 2000. Founded in 1946 by Bill Galt and Wilson McNeely, Jr., Americast is an independently-owned precast concrete and reinforced concrete pipe manufacturer, offering a broad range of products and services throughout the U.S. For the past 15 years, Americast has been in the forefront of designing, manufacturing and distributing various sanitary and stormwater treatment systems to meet their clients' regulatory requirements. From that experience, Filterra Bioretention Systems was developed and has quickly become recognized as a state-of-the-art stormwater solution in advanced bioretention treatment technology.

In 2000, Americast partnered with Larry Coffman to develop and patent the Filterra Stormwater Bioretention Filtration System. Larry Coffman, a renowned stormwater innovator, has over 33 years experience with planning and stormwater permitting in Prince George's County, Maryland, and is nationally known as the pioneer and developer of the Low Impact Development (LID) concept. Low Impact Development is a decentralized approach to stormwater management. Filterra Bioretention Systems model this approach because it controls stormwater runoff at the source, leaves a small footprint, is cost-effective, uses natural treatment processes and is aesthetically appealing

Filterra Bioretention Systems offers stormwater treatment technologies that optimize bioretention technology for enhanced pollutant removal Extensive lab and field monitoring has made Filterra the state-of-the-art technology in stormwater treatment and the urban solution to Low Impact Development.


filterra
Bioretention Systems
A Growing Idea in Stormwater Filtration
Bioretention
Plant/Soil/Microbe Complex
Removes Pollutants, TSS,
Phosphorus, Nitrogen, Bacteria,
Heavy Metals, Hydrocarbons, etc.
Filterra® Flow Line
at Higher Elevation
than Bypass Flow Line
New or Existing
Catch Basin,
Curb Cut or
Other Means of
Overflow Relief
Clean-out
High Flow Bypass
Curb and
Gutter
Storm Water Inflow
("First Flush")
3" Mulch
Filterra® Engineered
Media
Energy Dissipator
Stones
Filterra® Concrete
Container
Treated Stormwater
Underdrain System
A Division of AMERICAST
U.S. Patents #6,277,274 & #6,569,321. Other Patents pending.

Filterra®
Bacterra™
Washington GULD
San Diego Solution
Product Schematic
Options
Project Profiles
Maintenance
Plant Selections
White Paper
FAQ

Maintenance

While the technology behind the Filterra system is complex, maintenance is not. Unlike competitive systems, a standard maintenance agreement is included with the purchase of every unit and detailed maintenance records are kept and updated after each scheduled maintenance.

Although the first year of maintenance is FREE, an extended maintenance agreement is available. Allow the experts to continue to maintain your Filterra unit(s), and you won't have to worry with scheduling or record keeping.

Filterra maintenance includes: unit inspection, debris, trash and mulch removal and disposal, filter media evaluation, plant health evaluation, replacement of mulch, and updated and stored records of performed maintenance.

- Maintenance Steps

Request Design Assistance Kit

Photo Gallery

How Filterra Works
(Animation)

Search:

submit

Filterra is protected by U.S. Patents #6,277,274, #6,569,321 and #7,625,485. Other patents pending.

Filterra is a Division of Americast | 11352 Virginia Precast Road Ashland, VA 23005

Related content: stormwater management, surface water runoff, low impact development, design assistance stormwater, stormwater BMP, stormwater quality

Filterra® Maintenance Steps

1. Inspection of Filterra and surrounding area

2. Removal of tree grate and erosion control stones

3. Removal of debris, trash and mulch

4. Mulch replacement

5. Clean area around Filterra

6. Complete paperwork and record plant height and width

For additional information please contact your local Filterra sales representative.
Eastern Zone: 866-349-3458, Western Zone: 877-345-1450.

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StormTreat Systems

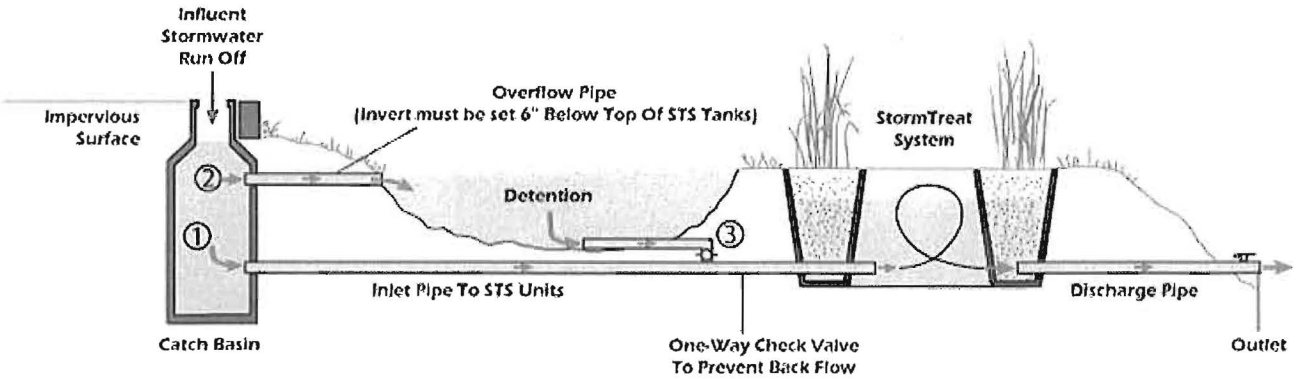
- Tour the System
- Configuration & Technical Data
  - Specifications
  - Sizing
  - Configurations
  - Installations
  - Maintenance
- Pollutant Removal Data
- Awards & Certifications
- Case Studies
- Contact Us
- Home

StormTreat Systems - The Natural Choice for Stormwater Treatment

StormTreat Systems may be installed using a variety of configuration options provided they abide by StormTreat and state specific design specifications. Following are a couple common configuration options for reference purposes.

1. **Conventional Detention** can be provided in a traditional detention pond or in a subsurface storage structure (tanks, pipe, arch-shaped chambers, etc.). We recommend that influent stormwater be directed first to the StormTreat tanks for treatment. This assures that smaller storms and the first flush of larger storms containing the most pollutant laden runoff receive thorough treatment within the StormTreat System and is also advantageous as the bioretention plants receive maximum watering from each storm event increasing plant health and drought resistance. When the StormTreat System fills to six inches below the tank rim, influent is directed to the detention structure using an overflow/flow splitter device in the catch basin. (See Figure 1 Below)

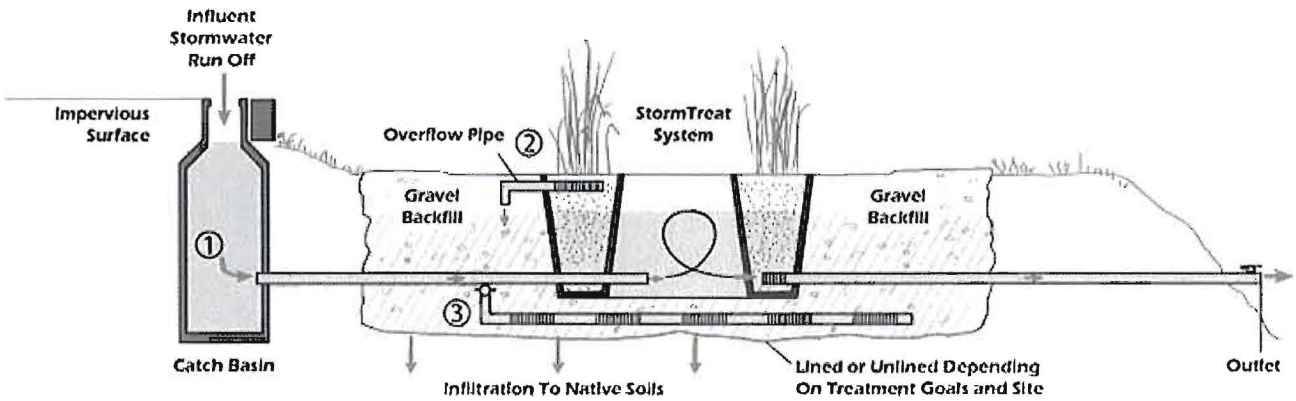
(FIGURE 1) CONVENTIONAL DETENTION



2. The **Backfill Detention and/or Infiltration** option utilizes the stone filled excavation area surrounding a STS tank in order to detain and treat the water quality volume. As in option 1 above, influent stormwater is first directed to the STS tank. When stormwater reaches an elevation six inches below the tank rim the overflow discharge pipe within the STS tank directs flow to the surrounding backfill area for detention where it is either returned to the STS tank for treatment or allowed to infiltrate into native soils. If configured for infiltration the site must be assessed for soil permeability to assure a sufficient infiltration rate is

available. Water discharged to the backfill area has already been treated in the sediment chamber and the bioretention area of the STS tank and will receive further treatment as it is either infiltrated to native soils or reintroduced into the STS tank. If water is to be reintroduced to the STS tank infiltration must be deterred either by impermeable soil type or by lining the backfill area with a "fish safe" liner. Also an additional inlet pipe fitted with a one-way check valve must be included to allow detained water to return to the tank. (See Figure 2 Below)

(FIGURE 2) BACKFILL DETENTION / INFILTRATION



Information & Technical Support: (508) 883-1033
Sales, Quotes and Installation: (877) 787-6426
65 Little River Road • Cotuit, Massachusetts 02635
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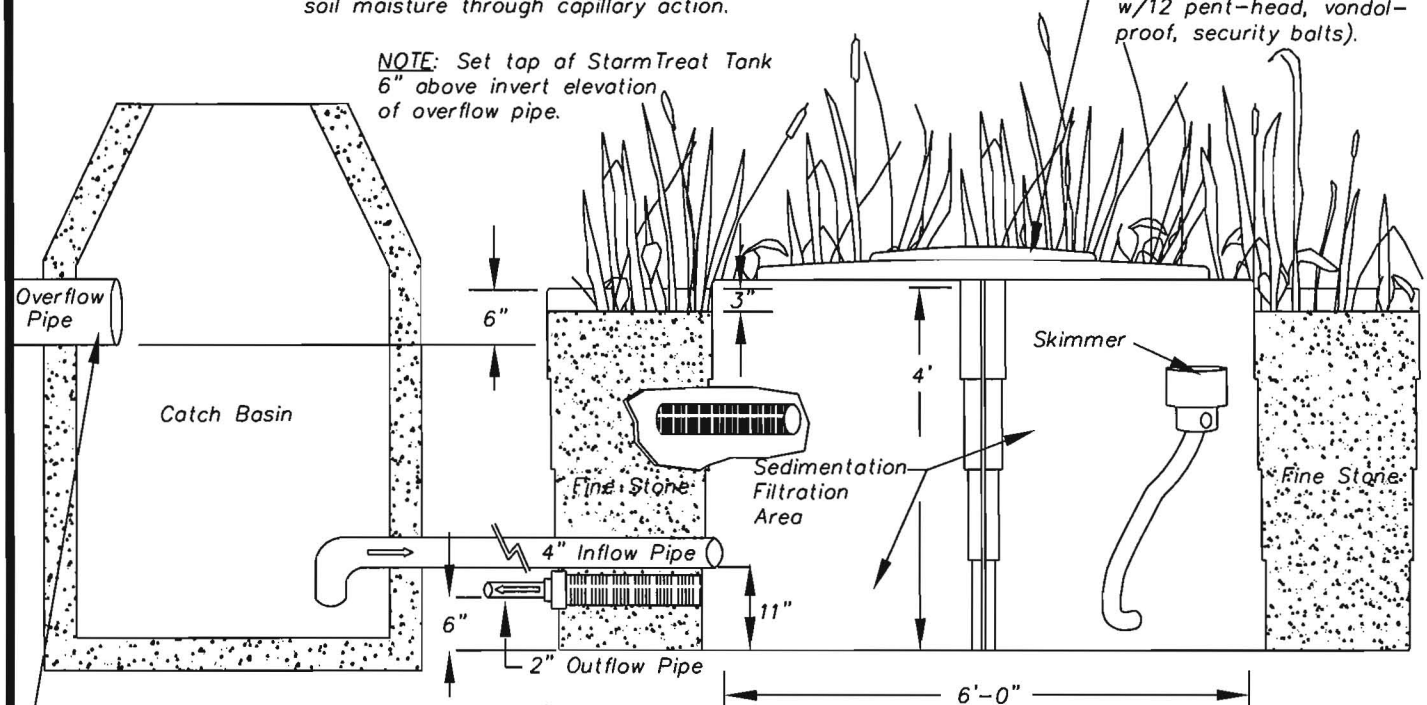
Installations | Maintenance | Pollutant Removal Data | Awards & Certifications | Case Studies | Contact Us | Home

STORMTREAT™ SYSTEMS, Inc. — Specification Sheet of StormTreat System Tank

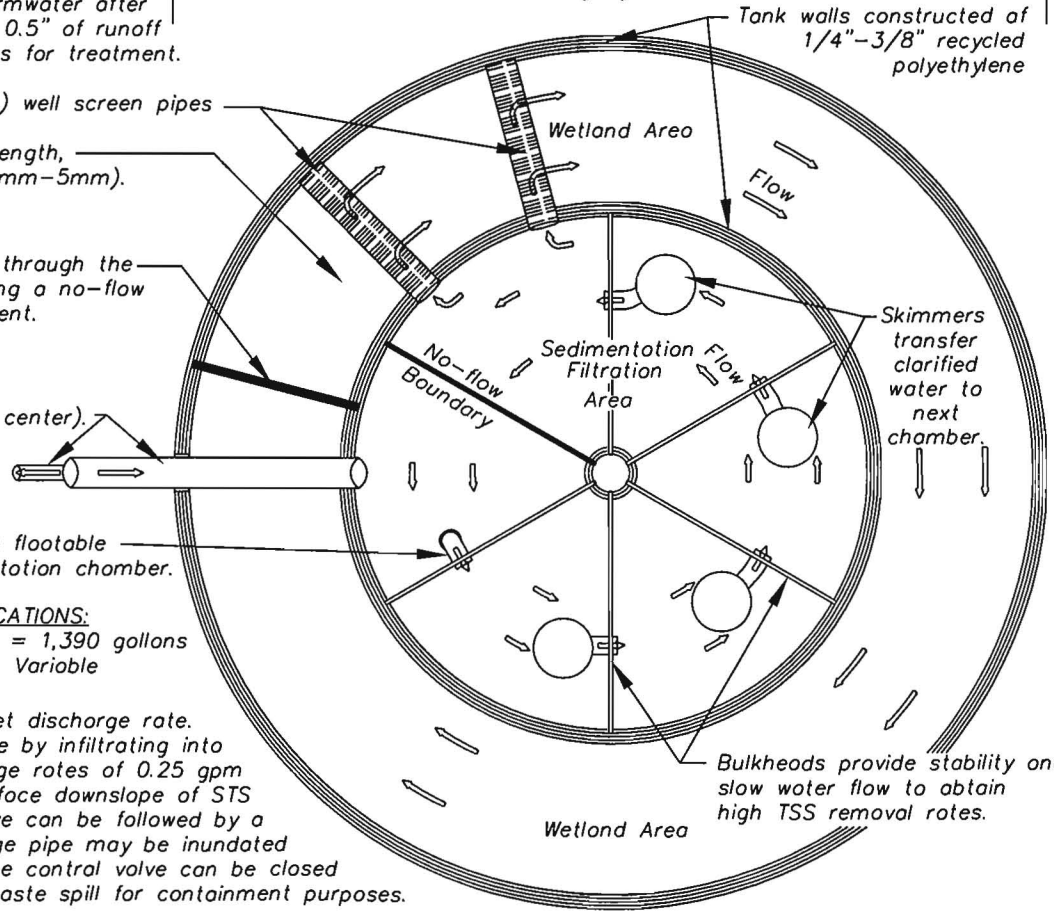
124 Route 6A, Sandwich, MA 02563
(508) 833-1033
TOLL FREE:
(877) 787-6426

US Patent No. 5,437,786

Wetland Plants include soft-stem bullrush (Scriptus validus) and burreed (Spargonium sp). The wetland plants are maintained between storms by a minimum of six inches of water in the bottom of the wetland basin. The standing water provides for soil moisture through capillary action.



Overflow pipe discharges stormwater after the "first flush". The initial 0.5" of runoff is captured by the STS Tanks for treatment.



OTHER SPECIFICATIONS:
Holding volume = 1,390 gallons
Holding time = Variable

Outlet control valve used to set discharge rate. Discharge can occur subsurface by infiltrating into moist soils due to low discharge rates of 0.25 gpm or can occur at the lands surface downslope of STS Tanks. The outlet control valve can be followed by a check valve where the discharge pipe may be inundated pipe during coastal floods. The control valve can be closed in the event of a hazardous waste spill for containment purposes.

StormTreat™ Systems

Maintenance Instructions

1. Check the discharge flow rate and adjust using the outlet control valve. The system is commonly designed to discharge at a rate of 2-gallons per minute per tank, although site-specific flow rate should be confirmed. The discharge rate can be found by directly measuring a timed-discharge volume if the outlet is accessible, or through falling-level measurements inside the sediment chamber. The total capacity of a tank is 1390 gallons and the height of the tank is 4 feet, therefore a 2-gallon per minute discharge rate can be observed as the water level in the tank falling at a rate of 4.15 inches per hour.

2. Measure sediment depth inside the sediment chambers and schedule a pump-out before depth reaches 5 inches (more regular pump outs will result in longer life of the bioretention area gravel filter). A future pump-out date can be estimated by projecting based upon sediment accumulation rates since the last measurement or since original installation. On average, StormTreat Systems need to have sediment removed once every three years. This can be done using a vacuum pump truck.

3. Observe wetland plant conditions and height during growing season. Wetland plants may need to be supplemented during the first three growing seasons depending upon local site conditions. Established plants should be trimmed back in order to maintain access to tank lids, debris and weeds should be cleaned from wetland gravel surface.

4. Systems that have not been regularly maintained should be thoroughly assessed for proper function and may require exchange of wetland gravel filter media as fines and collected pollutants can inhibit flow and cause clogging and system failure. Gravel can be removed using a vacuum pump truck and replacement of gravel should follow specifications and instructions listed on the installation document provided. If wetland plants are in good health they can be carefully removed before pumping out gravel and reinstalled.

Please contact StormTreat Systems with any maintenance related questions.

Email: Info@StormTreat.com

Phone: 508-833-1033

Contech Fitration

- Filtration
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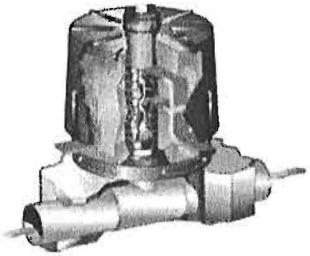
    - Media Options
    - Model Configurations
    - MFS
  - Volumetric Separation
  - Hydrodynamic Separation
  - Screening
  - Oil/Water Separation
  - CMP Detention
  - Concrete Detention
  - LID - Low Impact Development
  - Plastic Detention
  - Flow Control
  - Catch Basin Inserts
  - Permeable Pavement
  - BioFiltration
  - Trash Racks / Debris Cages

StormFilter

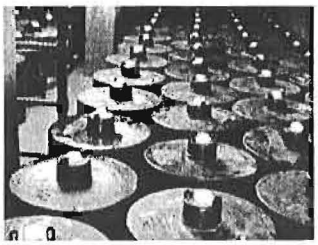
Siphon-actuated Filtration



Designed to meet stringent regulatory requirements, The Stormwater Management StormFilter® targets a full range of pollutants in urban runoff, including TSS, soluble heavy metals, oil and grease, and total nutrients. Its patented, surface-cleaning system prevents surface blinding, which extends the cartridge life cycle. The field-proven performance of the StormFilter has led to hundreds of regulatory agency approvals nationwide as a standalone BMP. This cost-effective, passive filtration system is highly reliable and easy to install.

StormFilter Benefits

- Various filtration media available to target site-specific pollutants
- Increased cartridge longevity due to uniform sediment loading
- Multiple configurations optimized for upstream treatment, downstream treatment, and infiltration applications
- Cartridge based system provides exact sizing
- Dry sump means no water to remove during maintenance



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  - Catch Basin Inserts
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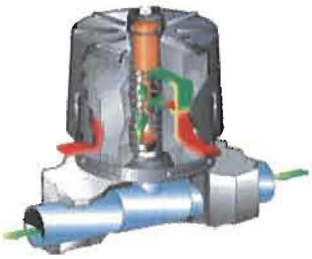
  - BioFiltration
  - Trash Racks / Debris Cages

StormFilter

Siphon-actuated Filtration



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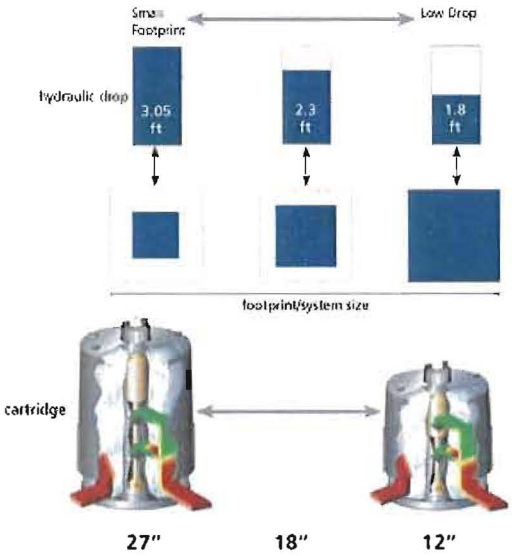
StormFilter Cartridge Options

With multiple cartridge heights available, you now have a choice when fitting a StormFilter system onto your site. The 27" cartridge provides 50% more treatment per square foot of system than the previously standard 18" cartridge. So, you are meeting the same treatment standards with fewer cartridges, which means a smaller system. If you are limited by hydraulic constraints, choose our low drop cartridge (12"), which provide filtration treatment with only 1.8 feet of headloss.

Cartridge Type	Hydraulic Drop (ft)	Treatment Capacity (gpm)	
		1 gpm/ft2	2 gpm/ft2
27"	3.05	11.25	22.5
18"	2.3	7.5	15
Low Drop	1.8	5	10



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Filtration Media Options

Our filtration products can be customized using different filter media to target site-specific pollutants. A combination of media is often recommended to maximize pollutant removal. More information is available in the StormFilter Configuration Guide.

PhosphoSorb™ is a lightweight media built from a Perlite base that removes total phosphorus (TP) by adsorbing dissolved-P and filtering particulate-P simultaneously.

- Download PhosphoSorb Performance Results

Perlite is naturally occurring puffed volcanic ash. Its porous, multi-cellular structure and rough edges make it effective for removing TSS, oil and grease.

- Download Perlite Peformance Results at 7.5 gpm
- Download Perlite Peformance Results at 15 gpm

CSF Leaf Media and **MetalRx** are created from deciduous leaves processed into granular, organic media. CSF is most effective for removing soluble metals, TSS, oil and grease, and neutralizing acid rain. MetalRx, a finer gradation, is used for higher levels of metal removal.

- Download CSF Performance Summary

Zeolite is a naturally occurring mineral used in a variety of water filtration applications. It is used to remove soluble metals, ammonium, and some organics.

GAC (Granular Activated Carbon) has a micro-porous structure with an extensive surface area to provide high levels of adsorption. It is primarily used to remove oil and grease and organics such as herbicides and pesticides.

ZPG™ is a proprietary blend of zeolite, perlite, and granular activated carbon media is used to provide an alternative for CSF media for installations where leaf media cannot be used.

- Download ZPG Performance Results

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Give Feedback

- Filtration
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    - Media Options
    - Model Configurations
      - CatchBasin StormFilter
      - Linear Grate StormFilter
    - MFS
  - Volumetric Separation
  - Hydrodynamic Separation
  - Screening
  - Oil/Water Separation
  - CMP Detention
  - Concrete Detention
  - LID - Low Impact Development
  - Plastic Detention
  - Flow Control
  - Catch Basin Inserts
  - Permeable Pavement
  - BioFiltration
  - Trash Racks / Debris Cages

StormFilter Model Configurations

The StormFilter technology can be configured to meet your unique site requirements. Following is a brief description of the available configurations. For more information download the StormFilter Configuration Guide.

Upstream Treatment Configurations

Low Impact Design (LID) design involves managing runoff close to the source using small, decentralized system. The following suite of StormFilter configurations are easily incorporated on sites where LID site design is recommended. These low-cost, lowdrop, point-of-entry systems also work well when you have a compact drainage area.

CatchBasin

- Provides a low cost, low drop, point-of-entry configuration
- Treats sheet flow from small sites
- Uses drop from the inlet grate to the conveyance pipe to drive the passive filtration cartridges

Curb Inlet

- Provides a low drop, point-of-entry configuration
- Accommodates curb inlet openings from 3 to 10 feet long
- Uses drop from the curb inlet to the conveyance pipe to drive the passive filtration cartridges

Linear Grate StormFilter / Linear StormFilter

- Can be designed to meet volume based sizing requirements
- Can be installed in place of and similar to a typical catch basin
- No confined space entry required for maintenance
- Accommodates up to 29 StormFilter cartridges
- Download Configuration Overview

Infiltration Configuration

DryWell

- Provides treatment and infiltration in one structure
- Available for new construction and retrofit applications
- Easy installation
- **Download Configuration Overview**

Roof Runoff Treatment Configuration

DownSpout

- Easily integrated into existing gutter systems to eliminate pollution from rooftop runoff
- Fits most downspout configurations and sizes
- Single or dual cartridge models available
- Treats up to 14,000 square feet of rooftop area per dual-cartridge system

- **Download Configuration Overview**

Downstream Treatment Configurations

Conventional stormwater treatment involves collecting, conveying and treating stormwater runoff with an end of pipe treatment system before discharging off-site. StormFilter configurations suitable for these applications are listed below and can be engineered to treat a wide range of flows.

Vault / Manhole

- Treats small to medium sized sites
- Simple installation - arrives on-site fully assembled

CON/SPAN / High Flow

- Treats flows from large sites
- Consists of large, precast components designed for easy assembly on-site
- Several configurations available, including: CON/SPAN, Panel Vault, Box Culvert, or Cast-In-Place
- Download CON/SPAN StormFilter Installation Guide

Volume

- Meets volume-based stormwater treatment regulations
- Captures and treats specific water quality volume (WQv)
- Provides treatment and control the discharge rate
- Can be designed to capture all, or a portion, of the WQv

Peak Diversion StormFilter

- Provides off-line bypass and treatment in one structure
- Eliminates material and installation cost of additional structures to bypass peak flows
- Reduces the overall footprint of the treatment system, avoiding utility and right-of-way conflicts
- Internal weir allows high peak flows with low hydraulic head losses
- Accommodates large inlet and outlet pipes (up to 36") for high flow applications
- Download Configuration Overview

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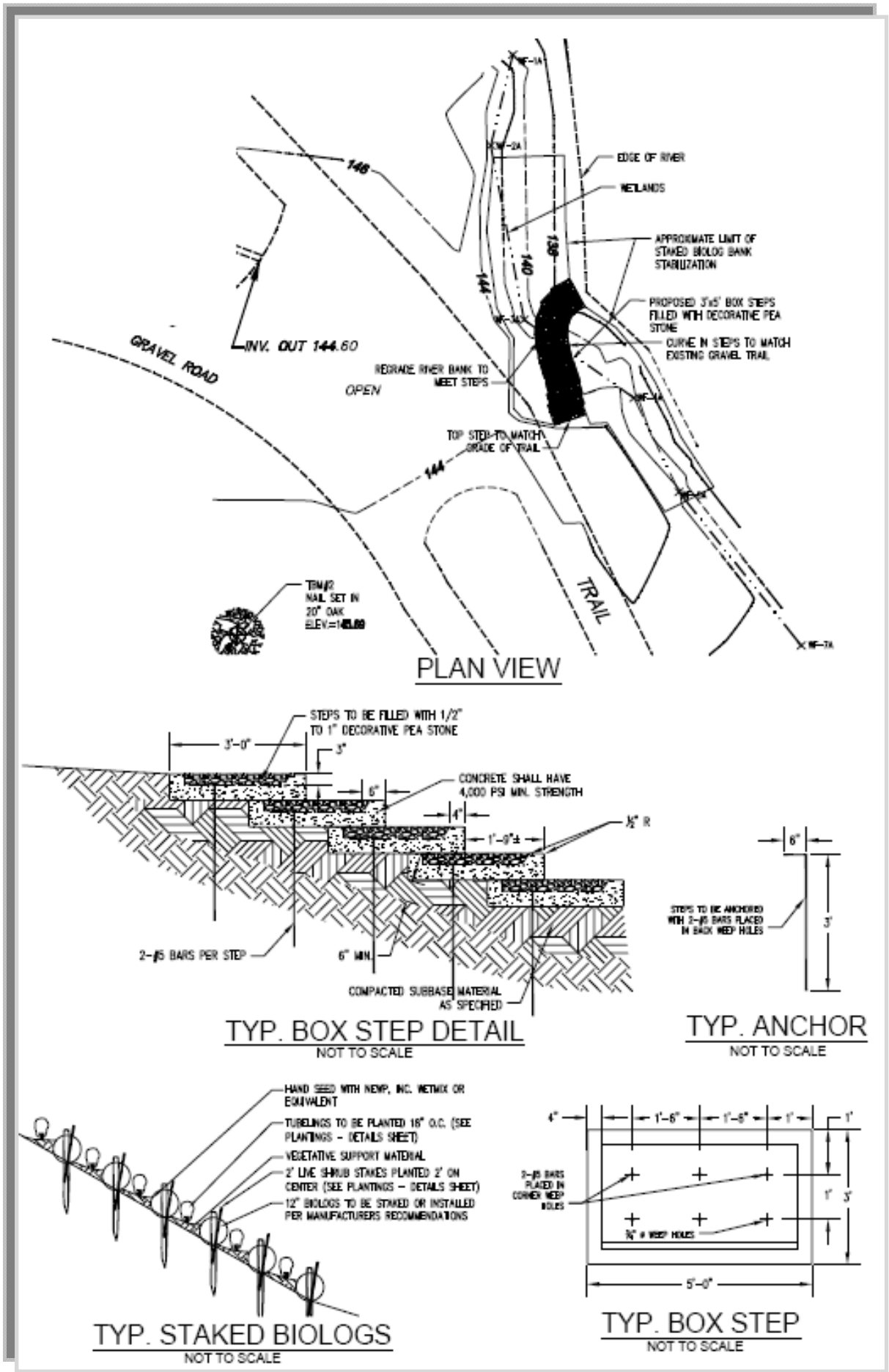
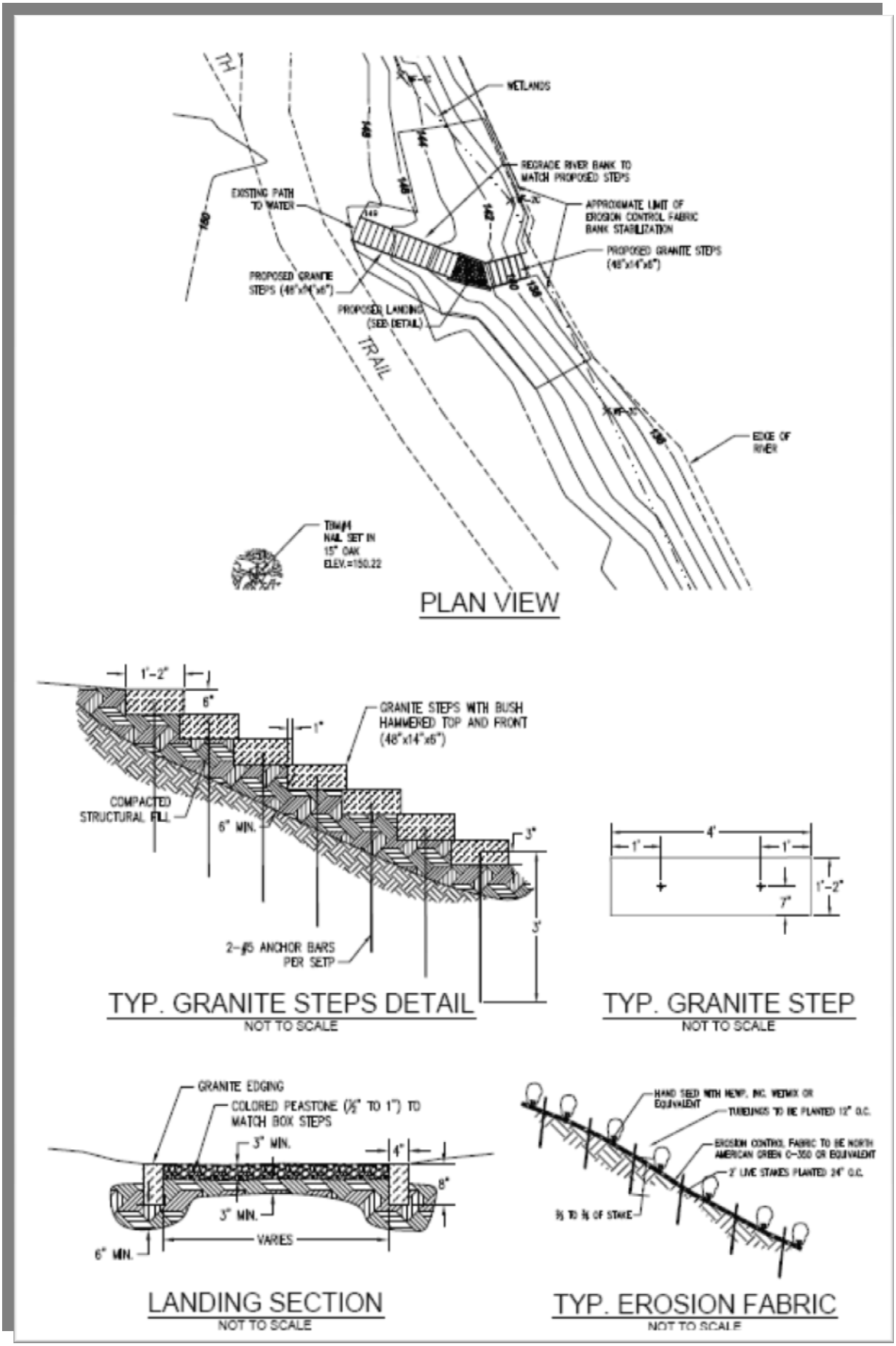
Give Feedback

Appendix F
Example Erosion Control Conceptuals



EXAMPLE: BOX STEPS AND BANK STABILIZATION
USING STAKED VEGETATED BIOLOGS
(FOR EXAMPLE ONLY – SITE SPECIFIC DESIGN REQUIRED)



EXAMPLE: GRANITE STEPS AND BANK STABILIZATION
USING VEGETATION AND EROSION CONTROL FABRIC
(FOR EXAMPLE ONLY – SITE SPECIFIC DESIGN REQUIRED)

Appendix G
2009 Lake Auburn Raw Water Testing

2009 LAKE AUBURN RAW WATER TESTING

January	April	July	October
TOC /DOC (intake)	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly
ALKALINITY (intake	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly
Giardia & Crypto/ Algae	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly
UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly
Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk
	InLake Samples (Weekly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS,TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS,TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.
	InLake Samples (Monthly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	**InLake Samples (Monthly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	**Perimeter** - **(One Rain event and 1x Monthly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, Nitrate/Nitrite (environmental), Total Phosphorus
	Wetlands - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	**Wetlands** - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	
		CORE (Monthly) Color, Nitrate/ite, Total Phosphorus, Ortho P, TOC, Chl a, Algae, Ammonia N)	
	Perimeter -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, conductivity, TDS	**Perimeter** -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, TDS	
	Total phosphorus, environmentall nitrate/nitrite 1x/mos	Total phosphorus, environmentall nitrate/nitrite 1x/mos	

February	May	August	November
TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly
ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly
Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly
UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly
Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk
	MTBE (intake & boat launch) Early in Month		
	InLake Samples (Weekly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.
	InLake Samples (Monthly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	**InLake Samples (Monthly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	**Perimeter** - **(One Rain event and 1x Monthly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, Nitrate/Nitrite (environmental), Total Phosphorus
	Wetlands - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	**Wetlands** - **(Monthly)** TDS, Conductivity, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	**Wetlands** - **(Monthly)** TDS, Conductivity, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci
		CORE (Monthly) Color, Nitrate/ite, Total Phosphorus, Ortho P, TOC, Chl a, Algae, Ammonia N)	
	Perimeter -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, conductivity, TDS	**Perimeter** -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, TDS	
	Total phosphorus, environmentall nitrate/nitrite 1x/mos	Total phosphorus, environmentall nitrate/nitrite 1x/mos	

March	June	September	December
TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly	TOC /DOC (intake) - monthly
ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly	ALKALINITY (Intake) - monthly
Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly	Giardia & Crypto/ Algae (Intake) - monthly
UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly	UV (Intake) - weekly
Entrance to system Fecal coliform, pH, Temp, Turbidity -7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity -7/wk	Entrance to system Fecal coliform, pH, Temp, Turbidity - 7/wk
	MTBE (intake & boat launch) Early in Month	**TOC at Milfoil area North Auburn**	
	InLake Samples (Weekly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci @ 4m. Deep Hole (8) Weekly - Secchi disk, DO & temp at each meter.	**InLake Samples (Weekly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.
	InLake Samples (Monthly): - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	**InLake Samples (Monthly)**: - Sites 6,7,8,9,10,11,12,Salmon Point - pH, Turbidity, Conductivity, TDS, TC/FC/EC/Enterococci at 4 meter depth intervals.	
	Wetlands - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	**Wetlands** - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci	**Wetlands** - **(Monthly)** TDS, Color, Turbidity, DO, Temp, pH, TC/FC/EC/Enterococci
	CORE (Monthly) Color, Nitrate/ite, Total Phosphorus, Ortho P, TOC, Chl a, Algae, Ammonia N)	**CORE (Monthly)** Color, Nitrate/ite, Total Phosphorus, Ortho P, TOC, Chl a, Algae, Ammonia N)	
	Perimeter -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, TDS	**Perimeter** -**(Biweekly)** TC/FC/EC/Enterococci, temperature, DO, turbidity, color, pH, coductivity, TDS	
	Total phosphorus, environmentall nitrate/nitrite 1x/mos	Total phosphorus, environmentall nitrate/nitrite 1x/mos	