ACRP

FACT SHEETS

AIRPORT
COOPERATIVE
RESEARCH
PROGRAM

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On-Site Monitoring Methods

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

FACT SHEETS

On-Site Monitoring Methods #58–100

ACRP Report 72

Guidebook for Selecting Methods to Monitor
Airport and Aircraft Deicing Materials

AIRPORT COOPERATIVE RESEARCH PROGRAM 2012

LEGEND FOR FACT SHEETS

Method and Use Status		Notes
Parameter		Identifies parameter being considered.
Type	Online Monitor, Handheld Monitor or Test Kit	Identifies equipment type being considered.
Method Description		Method name and general description of method or equipment.
Level of Technology Development	Emergent	1-5 years
	Evolving	5-15 years
	Well Established	15+ years
Demonstrated Technology for Airport Stormwater?	Yes	Typical installation or is a demonstrated airport technology.
	No	Atypical installation and no known usage at airports.
General Availability of Technology	Single Manufacturer	1 manufacturer
	Few Manufacturers	2-5 manufacturers
	Many Manufacturers	5+ manufacturers
Implementation Considerations		
Typical Installation Locations		- Outfall discharge (typically low concentration) - Diversion/treatment influent (typically high concentration) - Collection system monitoring (wide range of concentrations) - Treatment effluent (typically low concentration not glycols). Applicable to online monitors only.
Regulatory-Approved Method	Federal Approval (Method Name/Number)	U.S. EPA or Standard Method approved.
	State or Local Approval	Approved by specific state or local authorities
	None Reported	No known approvals for method, based on results of airport survey and information from manufacturers.
Measurement Range		Parameter concentration range the method or equipment is able to detect.
Accuracy		Accuracy as a percent of the measured value (or full range value if noted).
Response Time		Typical timeframe necessary to obtain parameter concentration from method.
Siting Constraints/Needs		Description for online monitors only to identify special site conditions or infrastructure needed for equipment to operate (i.e., utilities).
Flow and Stream Constraints		Description of flow or stream constraints needed for equipment to operate properly.
Interferences		List of chemical or physical interferences and concentrations (where available) for the method.
Staff Time Requirements	Low	Less than 1 hour/week to perform test and for typical maintenance/operations.
	Moderate	Between 1 and 4 hours/week to perform test and for typical maintenance/operations.
	High	More than 4 hours/week to perform test and for typical maintenance/operations
Level of Staff Knowledge	Low	Only general understanding of equipment and use is necessary for successful operation.
	Moderate	Moderate level of understanding including equipment operation, maintenance, and calibration. Training may be necessary for successful operation.
	High	High level of understanding including operation, maintenance, calibration, ability to troubleshoot. Training is required for successful operation.

LEGEND FOR FACT SHEETS

Method and Use Status		Notes
O&M Issues		List of known operational and maintenance issues such as calibration, cleaning, replacement of parts or equipment, etc.
Data Retrieval		Visual; Local Readout; Ethernet; Analog Connection; Serial Port Connection; USB Connection; Wireless Communication; Datalogger; Web Interface.
Recommended Features		Identifies equipment features that are recommended if the method or equipment is to be implemented at airport.
Optional Features		List of optional features for equipment provided by at least one manufacturer. Recommended optional system components are listed in the notes section.
Typical Costs		
Capital Cost	Very Low	For the purchase of the equipment. Equipment listed as optional system components in notes section is not included. Less than $2,000
	Low	$2,000-10,000
	Medium	$10,000-25,000
	High	$25,000-50,000
	Very High	$50,000+
Typical Additional Capital Cost	Low	For online monitors only Less than $2,000
	Medium	$2,000-10,000
	High	$10,000+
Annual Operations and Maintenance Cost	Low	Typical costs of a service contract. Staff labor is accounted for in “Staff Time Requirements.” Handheld and Test Kits: Less than $500 Online Monitors: Less than $2,000
	Medium	Handheld and Test Kits: $500-2,000 Online Monitors: $2,000-8,000
	High	Handheld and Test Kits: $2,000+ Online Monitors: $8,000+

FACT SHEET 58

Biochemical Oxidation

1. Description

Analytical Process

This unit continuously collects a sample from the storm water sample loop. The solids are reduced by the configuration of the intake port located in the sample loop. The sample is conditioned by increasing the temperature to approximately 86° Fahrenheit and adding nutrients and oxygen. The instrument measures the influent DO and then feeds the sample into a vessel containing bacteria. The bacteria degrade the deicer and consume DO in the process. The instrument then measures the DO of the effluent from the unit. The monitor controls the flow rate of the sample stream to maintain a constant DO drop. BOD concentration is correlated to the flow rate of sample required to maintain the DO drop. See Chapter 5 of the guidebook for discussion of correlation to other parameters.

If there is insufficient BOD to maintain the bacteria, the monitor will periodically feed a substrate food source into the bacteria to maintain the population.

Advantages

Most closely approximates the U.S. EPA-approved 5-Day BOD method.

A study has been conducted indicating good correlations with lab BOD data (Portland International).

Some airport operators have gained local or state regulator approval for compliance monitoring purposes.

Disadvantages

Requires maintenance of living bacteria to make a measurement.

High sample flow rate required for sample intake (see notes).

Internal tubing has the potential to clog due to biological growth.

Some airports have found it difficult to maintain and keep calibrated.

Notes

Most significant reason for use: compliance with low-concentration BOD limits required (between 15 and 100 mg/L).

Most significant reason to avoid: high amount of maintenance required.

Typical equipment includes monitor unit and sample loop piping.

Recommended system components include sample shelter.

Typical replacement items include internal pumps and DO probes.

Consumables include nutrient solutions, glycol solutions, calibration standards, and tubing.

Significant changes in concentrations may require up to 45 min. for reading to stabilize.

Instrument requires a sample intake of between 5 and 35 gpm. This can be independent of the stream flow rate since sample can be a loop flow from a sump. The instrument uses the sample loop velocity and sample intake configuration to avoid filtering the sample. The discharge from the sample loop will have the same concentration as the influent so it is recommended that this be returned upstream of sample diversion location. The monitor also alarms if sample loop runs dry, so recommendation is to withdraw and return sample loop to same location. The monitor can also use a significant amount of water (several thousand gallons of water per month) for sample dilution, so a continuous water supply is recommended.

Airport users reported that a time-intensive operations and maintenance program is needed to achieve good results. The instrument has an auto-calibration feature, and the recommended frequency is daily using glycol solutions. The calibration solutions tend to degrade over time, especially if not kept chilled, so replacement may be required every 4 to 6 weeks to prevent mis-calibration. Calibration checks are recommended monthly, at a minimum, by feeding a glycol calibration standard into the manual sample port. Maintenance or replacement is required annually on the internal pumps and DO probes. Airports have reported delays in getting replacement parts from the manufacturer. The instrument uses 1970s era DOS-based software, which has limited communication functionality; communication with the instrument can only be performed with a modem and analogue-based phone, both of which are obsolete.

Additional Notes for Startup

Startup requires a minimum of 2 days (up to 2 weeks) to develop the living bacteria culture. Some users suggest chilled storage of the bacteria at the end of the deicing season to aid in the next season startup. The DO probes also require storage in water when not in use.

2. Selection Criteria

Method and Use Status

Parameter	Biochemical oxygen demand (BOD).
Type	Online monitor.
Method of Description	Biochemical oxidation. Bacteria degrade organic chemicals in the water sample with the resulting dissolved oxygen change measured.
Level of Technology Development	Well established.

Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent.
Regulatory-Approved Method	Approved by specific state or local authorities.
Measurement Range	20 to 100,000 mg/L BOD (by manufacturer—airport testing indicated accurate as low as 5 mg/L).
Accuracy	±3%.
Response Time	Programmable, 3 min. minimum (see notes).
Siting Constraints/Needs	- Potable water, filtered. - Electricity. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required. - Sample pump flow rate is recommended to be between 5 to 35 gpm (15 gpm typical). - Chlorine and sediment filters required for potable water line. - Water softener may be necessary for potable water if hardness is greater than 100 mg/L.
Interferences	Pollutants that can kill or inhibit bacteria (i.e., fuel, AFFF, and potentially high concentrations of pavement deicer).
Staff Time Requirements	High.
Level of Staff Knowledge	High.
O&M Issues	- Bacteria are sensitive to environmental conditions, and successful operation is dependent on maintaining steady population of bacteria. - If bacteria are inhibited, instrument can provide inaccurate readings or go offline. - High maintenance is required to prevent small-diameter tubing from clogging. - DO probe maintenance is essential for accurate measurements. - Recommend PG to maintain bacteria when sample BOD is low—not ADF because additives can inhibit bacteria.
Data Retrieval	Local readout, analog connection.
Recommended Features	Offline manual sample operation (included in standard units).
Optional Features	None.

Typical Costs

Capital Cost	Very high.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Medium.

FACT SHEET 59

Photochemical Oxidation

1. Description

Analytical Process

The instrument collects a sample from a continuous sample loop at a programmable time interval (up to 4 per hour). The sample is withdrawn from the sample loop through a filter. The sample is fed into a reaction chamber containing a titanium dioxide sensor. The titanium dioxide sensor is exposed to UV light, and an electrical potential is applied. The UV light and the titanium dioxide oxidize the deicer, and the analyzer measures the electrons that are given off. The resulting current caused by the electron is correlated to COD. See Chapter 5 for discussion of correlation to other parameters.

Note: Prior to sampling, the range of COD concentration must be selected and the instrument calibrated to that range.

Advantages

No handling or disposal of hazardous reagents is required.

Very small sample volumes required.

Results in mg/L COD have potential to correspond to the units of many permits.

Less expensive per sample to operate than COD test kit.

Disadvantages

Recalibration is required for each of the four ranges of concentrations.

Recalibration is required as frequently as every 25 samples tested.

Consumables (electrolyte reagents, titanium dioxide sensors, sample filters) must be replenished as frequently as every 5 days, depending on operational conditions.

Notes

Most significant reason for use: method similar to COD method used for compliance.

Most significant reason to avoid: untested for airport storm water use.

Typical equipment includes monitor unit and sample loop piping.

Recommended system components include sample shelter.

Typical replacement items include internal pump motor, solenoid valve, and reference electrode.

Consumables include electrolyte reagents, titanium dioxide sensors, sample filters, calibration standards, and tubing.

The unit can switch between the following ranges (in mg/L COD): 0–25; 0–150; 0–1,500; 0–15,000. The unit will signal an alarm if a sample concentration is over the range.

The unit should be recalibrated approximately every 25 samples or when the range is changed by feeding a sorbitol solution into the manual sample port. Keep the calibration solutions chilled when not in use or replace every 4 to 6 weeks because the calibration solution tends to degrade over time.

The typical lifetime of the reference electrode is 12 to 20 months.

Since this unit has not been installed at an airport, the potential for biofouling of sample tubing is unknown, but expected, because of the biofouling experience by other monitors. A chlorination system is recommended to be tested if biofouling does occur (see Fact Sheet 65). The unit has been used successfully in the wastewater industry.

Bench top and portable models are similar and have the same accuracy. Bench top and portable model information is on Fact Sheet 61.

2. Selection Criteria

Method and Use Status

Parameter	Biochemical oxygen demand (BOD).
Type	Online monitor.
Method of Description	Photochemical oxidation. Titanium dioxide with a UV light catalyst degrades the chemicals in the water sample, and the electrochemical potential change is measured. The electrochemical potential change is correlated to COD.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0.2 to 15,000 mg/L COD (see notes).
Accuracy	±5%.

Response Time	Programmable, 15 min. minimum.
Siting Constraints/Needs	- Potable water, filtered. - Electricity. - Compressed air. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required. - Sample pump flow 10 gpm (minimum). - 25 to 50 µm filter is recommended.
Interferences	Chlorides (>2,000 mg/L).
Staff Time Requirements	Medium.
Level of Staff Knowledge	Moderate.
O&M Issues	Must be calibrated if switching between concentration ranges (see notes).
Data Retrieval	Local readout, analog connection, USB connection.
Recommended Features	Offline manual sample operation (included in standard units).
Optional Features	Dual stream sampling.

Typical Costs

Capital Cost	High
Typical Additional Capital Cost	Low
Annual Operations and Maintenance Cost	High

FACT SHEET 60

Electrochemical Oxidation

1. Description

Analytical Process

The instrument collects a sample from a continuous sample loop at a programmable time interval (up to 15 per hour). The sample is fed into a reaction chamber where an electrode creates hydroxyl radicals that oxidize the deicer in the sample. The instrument measures the change in electrical potential created and reports the results as COD. See Chapter 5 of the guidebook for discussion of correlation to other parameters.

Advantages

No handling or disposal of hazardous reagents is required.

Disadvantages

Pavement deicers cause interference with readings because of the change in storm water conductivity.

Internal tubing has the potential to clog due to biological growth.

Notes

Most significant reason to avoid: issues with potential pavement deicer.

Typical equipment includes monitor unit and sample loop piping.

Recommended system components include sample shelter.

Typical replacement items include electrodes and internal pumps.

Consumables include reagents, calibration standards, and tubing.

Airport users reported pavement deicing materials can cause significant inaccuracy in readings.

The instrument has an auto-calibration and the recommended frequency is daily. Recommended calibration solution is potassium hydrogen phthalate (KHP). Calibration checks are recommended monthly by feeding a KHP calibration standard (for full range) followed by deionized water (for zero) into the manual sample port.

2. Selection Criteria

Method and Use Status

Parameter	Chemical oxygen demand (COD).
Type	Online monitor.
Method of Description	Electrochemical oxidation. Electrical current degrades the chemicals in the water sample and the electrochemical potential change is measured. The electrochemical potential change is correlated to COD.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No. [Note: Tested and discontinued at Wilmington, Ohio (ILN)].
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	1 to 100,000 mg/L COD.
Accuracy	±5%.
Response Time	30 sec.
Siting Constraints/Needs	- Potable water. - Electricity. - Compressed air. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required. - Sample pump flow rate up to 3 gpm.
Interferences	High salt concentrations (can be from pavement deicers).
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	Tubing can get clogged with biological growth.
Data Retrieval	Local readout, analog connection, serial port connection.
Recommended Features	Offline manual sample operation (included in standard units).
Optional Features	Dual stream sampling.

Typical Costs

Capital Cost	High.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 61

Photochemical Oxidation

1. Description

Analytical Process

A sample is collected, filtered, and placed in a small beaker. The intake tubing of the unit is placed into the sample, and it is fed into a reaction chamber containing a titanium dioxide sensor. The titanium dioxide sensor is exposed to UV light, and an electrical potential is applied. The UV light and the titanium dioxide oxidize the deicer, and the analyzer measures the electrons that are given off. The measurement is reported as COD. See Chapter 5 for discussion of correlation to other parameters.

Note: Prior to sampling, the range of COD concentration must be selected and the instrument calibrated to that range. The range is typically selected based on previous results or compliance/diversion concentration.

Advantages

No handling or disposal of hazardous reagents (i.e., chromium or mercury) is required.

Less expensive operation per sample than COD test kit (dichromate method).

Disadvantages

Must be recalibrated for each of the four ranges of concentrations.

Must be recalibrated as frequently as every 25 samples tested.

Consumables must be replenished as frequently as every 5 days, depending on operational conditions.

Notes

Most significant reason for use: faster result than U.S. EPA-approved COD method.

Most significant reason to avoid: not a U.S. EPA-approved method.

Typical equipment includes monitor unit and filtration unit.

Recommended system components: none.

Typical replacement items: none.

Consumables include electrolyte reagents, titanium dioxide sensors, sample filters, and calibration standards.

Available as either a handheld (portable) unit or benchtop unit. The unit can switch between the following ranges (in mg/L COD): 0–25; 0–150; 0–1,500; 0–15,000.

Online models are similar and have the same accuracy. Online model information is contained in Fact Sheet 59.

2. Selection Criteria

Method and Use Status

Parameter	Chemical oxygen demand (COD).
Type	Test kit.
Method of Description	Photochemical oxidation. Titanium dioxide with a UV light catalyst degrades the chemicals in the water sample, and the electrochemical potential change is measured. The electrochemical potential change correlated to COD.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	0.2–15,000 mg/L COD (see notes).
Accuracy	±5%.
Response Time	6 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	Chlorides in concentration above 2,000 mg/L.
Staff Time Requirements	Medium.
Level of Staff Knowledge	Moderate.
O&M Issues	- Replace consumables. - Must be calibrated for specific concentration ranges (see notes).
Data Retrieval	Local readout, USB connection.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	High.

FACT SHEET 62

Colorimetric (Dichromate)

1. Description

Analytical Process

A sample is collected and pipetted into a reaction vial containing an oxidant (sulfuric acid) and an indicator compound (dichromate). The sample is then digested for two hours at 150°C. The oxidant converts the deicer and in the process the dichromate is reduced to chromic ions, which are green. The color of the sample is then measured using a photometer or spectrophotometer and reported as mg/L COD. See Chapter 5 for discussion of correlation to other parameters.

Advantages

Simple procedure.

U.S. EPA approved method and familiar method to most regulators.

Can test multiple samples as a batch.

Low maintenance.

Disadvantages

Extended time until result—typical time to perform analysis is 2.5 to 3 hours.

Standard method results in chromium and mercury waste.

Data from a color wheel is qualitative (i.e., reported as a range rather than a specific value).

Notes

Most significant reason for use: U.S. EPA-approved method.

Most significant reason to avoid: time delay to sample result and not online.

Typical equipment includes sample tubes, sample digester, and photometer/spectrophotometer.

Recommended system components: none.

Typical replacement items include photometer/spectrophotometer light source.

Chlorine removal methods are available for this method if sample has high chlorine content.

Consumables include reagents for test and have a shelf life of 5 months.

Dichromate method (with and without mercury) includes U.S. EPA-approved analysis concentration ranges: 3–150 mg/L and 20–1,500 mg/L. The 0.7–40 mg/L range and 200–15,000 mg/L range are not U.S. EPA-approved methods. A non-U.S.-EPA-approved method that uses manganese instead of mercury and chromium is available for the range of 20–1,000 mg/L COD—this method does not generate a hazardous waste.

A blank solution is used to zero the photometer or spectrophotometer during each test. A photometer has internal calibration software that can be updated by downloading the program from the manufacturer's website. Recommend checking for calibration updates every 6 months or annually.

Accuracy of method may be confirmed by creating a standard curve of samples with known COD concentrations.

2. Selection Criteria

Method and Use Status

Parameter	Chemical oxygen demand (COD).
Type	Test kit.
Method of Description	Colorimetric (dichromate). Organic chemicals are broken down in an acid–dichromate solution to form a pink-colored chromium complex. The COD concentration is determined by comparison of the sample to a color chart or measuring the light intensity using a photometer or spectrophotometer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 410.4).
Measurement Range	0 to 15,000 mg/L COD.
Accuracy	±5 mg/L.
Response Time	1 to 2 hours.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Chlorine (>1,000 mg/L). - Ammonia (>50 mg/L).
Staff Time Requirements	Low.

Level of Staff Knowledge	Low.
O&M Issues	None known.
Data Retrieval	Visual, local readout.
Recommended Features	None known.
Optional Features	Mercury and chromium-free reagents available (non-U.S.-EPA-approved method).

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 63

Thermal Catalytic Combustion

1. Description

Analytical Process

TOC monitors generally make two measurements: inorganic carbon (mineral or generally carbonate compounds) and total carbon. The TOC is determined by subtracting the inorganic carbon from the total carbon.

This unit collects a sample from the sample loop at a programmable time interval (up to 20 per hour). Most instruments filter the sample. The sample is then split into two parts. One sample is mixed with acid, which converts the inorganic carbon to carbon dioxide. The volume of carbon dioxide from inorganic carbon is measured. The second sample is then fed into a high-temperature furnace that converts all of the carbon into carbon dioxide. The volume of carbon dioxide from all carbon is measured. The inorganic carbon is subtracted from the total carbon to determine the TOC. Note: The concentration of inorganic carbon in airport storm water is typically expected to be negligible compared to the total carbon, so some manufacturers configure the instrument to measure only total carbon. See Chapter 5 for discussion of correlation to other parameters.

Advantages

No handling or disposal of hazardous reagents is required.

Measures the full range of potential deicer concentrations in airport storm water.

Uses an approved U.S. EPA method.

Disadvantages

Filtration system maintenance is required.

Internal tubing has the potential to clog due to biological growth.

Some costly parts require periodic replacement.

Delayed start-up while furnace achieves temperature.

Potential for pavement deicer high concentrations to increase maintenance required.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: time delay for unit to start (furnace temperature).

Typical equipment includes monitor unit and sample loop piping.

Recommended system components include sample shelter and bleach solution feed.

Typical replacement items include internal pumps, furnace lining (1 year), and furnace unit (3 years).

Consumables include air filter, carbon dioxide filter, sample filters, reagents, calibration solutions, and tubing.

Range of instrument must be selected at time of purchase—examples are (in mg/L TOC): <200; <4,000; <50,000.

Airport users reported good results with proper operations and maintenance program. Biogrowth may be controlled by injecting low-concentration bleach solution into sample line.

The instrument has an auto-calibration feature, and the recommended frequency is daily. Recommended calibration solution is potassium hydrogen phthalate (KHP). Calibration checks are recommended monthly by feeding a KHP calibration standard (for full range) followed by deionized water (for zero) into the manual sample port.

2. Selection Criteria

Method and Use Status

Parameter	Total organic carbon (TOC).
Type	Online monitor.
Method of Description	Thermal catalytic combustion. High temperatures burn the carbon in the water sample, and the release of carbon dioxide is measured.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 415.1).
Measurement Range	0 to 5,000 mg/L TOC (see notes). (Up to 50,000 mg/L TOC depending on manufacturer and model)
Accuracy	±2%.

Response Time	Programmable, 3 min. minimum.
Siting Constraints/Needs	- Potable water (depending on manufacturer and model). - Electricity. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required. - Pre-filters required (depending on manufacturer and model). - Sample pump flow rate is recommended to be between 3 to 30 gpm (15 gpm, typical).
Interferences	None known.
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	High concentrations of suspended solids or salts can cause increased maintenance.
Data Retrieval	Local readout, analog connection.
Recommended Features	- Offline manual sample operation (included in standard units). - Potable water available for ease of maintenance (required for operation of some units).
Optional Features	- Dual stream sampling. - Additional parameter measured (total nitrogen). - Serial port connection.

Typical Costs

Capital Cost	High.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Medium.

FACT SHEET 64

UV/Persulfate Oxidation

1. Description

Analytical Process

TOC monitors generally make two measurements: inorganic carbon (mineral, or generally carbonate compounds) and total carbon. The TOC is determined by subtracting the inorganic carbon from the total carbon.

This unit collects a sample from the sample loop at a programmable time interval (up to 8 per hour). Most instruments filter the sample. The sample is then split into two parts. One sample is mixed with acid, which converts the inorganic carbon to carbon dioxide. The volume of carbon dioxide from inorganic carbon is measured. The second sample is then fed into a chamber with persulfate and exposed to ultraviolet light, which converts all of the carbon into carbon dioxide. The volume of carbon dioxide from all carbon is measured. The total carbon is subtracted from the inorganic carbon to determine the TOC. See Chapter 5 for discussion of correlation to other parameters.

Advantages

Uses an approved U.S. EPA method.

Disadvantages

May not measure the full range of potential deicer concentrations in airport storm water.

Filtration system maintenance is required.

Internal tubing has the potential to clog due to biological growth.

Potential for pavement deicer interferences at high concentrations.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: chemical required for operation.

Typical equipment includes monitor unit, sample loop piping, and air compressor.

Recommended system components include sample shelter and bleach solution feed.

Typical replacement items include internal pumps and UV lamp (2 years).

Consumables include carbon dioxide filter, sample filters, reagents, calibration solutions, and tubing.

Range of instrument must be selected at time of purchase. Examples are (in mg/L TOC): <10; <100; <500; <1,000; <5,000; <10,000; <50,000.

One airport user reported adding a bleach solution feed to prevent biological growth in tubing.

The instrument has an auto-calibration feature; the recommended frequency is daily. Recommended calibration solution is potassium hydrogen phthalate (KHP). Calibration checks are recommended monthly by feeding a KHP calibration standard (for full range) followed by deionized water (for zero) into the manual sample port.

2. Selection Criteria

Method and Use Status

Parameter	Total organic carbon (TOC).
Type	Online monitor.
Method of Description	UV/Persulfate oxidation. Sodium persulfate with UV light degrade the carbon in the water sample and the release of carbon dioxide is measured.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 415.1).
Measurement Range	0 to 10,000 mg/L TOC (see notes). (Up to 50,000 mg/L TOC depending on manufacturer and model.)
Accuracy	±4% (or as low as ±2% depending on manufacturer and model).
Response Time	Programmable, 8 min. minimum.
Siting Constraints/Needs	- Potable water. - Electricity. - Compressed air. - CO_2 scrubber. - Venting for reaction gases. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required.

	- Sample intake and discharge up to 15 gpm (on some models).
Interferences	Salt (>0.5%).
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	- Tubing can get clogged with biological growth. - High salts and hardness can cause increased maintenance.
Data Retrieval	Local readout, analog connection.
Recommended Features	Offline manual sample operation (included in standard units).
Optional Features	- Serial port connection and datalogger. - Dual stream sampling.

Typical Costs

Capital Cost	High.
Typical Additional Capital Cost	Medium.
Annual Operations and Maintenance Cost	High.

FACT SHEET 65

UV/Ozone Oxidation

1. Description

Analytical Process

TOC monitors generally make two measurements: inorganic carbon (mineral, or generally carbonate compounds) and total carbon. The TOC is determined by subtracting the inorganic carbon from the total carbon.

This unit collects a sample from the sample loop at a programmable time interval (up to 8 per hour). The sample is then split into two parts. One sample is mixed with acid, which converts the inorganic carbon to carbon dioxide. The volume of carbon dioxide from inorganic carbon is measured. The second sample is then fed into a chamber with ozone and sodium hydroxide (caustic soda) and exposed to ultraviolet light, which converts all of the carbon into carbon dioxide. The volume of carbon dioxide from all carbon is measured. The total carbon is subtracted from the inorganic carbon to determine the TOC. See Chapter 5 for discussion of correlation to other parameters.

Advantages

Back flushing feature helps prevent clogging.

Larger diameter tubing helps prevent clogging.

Measures the full range of potential deicer concentrations in airport storm water.

Disadvantages

Ozone generator required.

Use of caustic requires handling safety precautions.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: ozone and caustic required for operation.

Typical equipment includes monitor unit, sample loop piping, and ozone generator.

Recommended system components include sample shelter.

Typical replacement items include internal pumps and electronic relays.

Consumables include air filter, sample filter, reagents, calibration solutions, and tubing.

Range of instrument can be selected automatically or manually during operation; examples include (in mg/L TOC): <1,250; <10,000; <15,000; <100,000.

The instrument has an automatic calibration check feature with a programmable frequency (daily is typical) using a calibration solution. Operation experience is with glycol calibration solution. Note that glycol calibration solutions tend to degrade over time so replacement every 4 to 6 weeks will help prevent mis-calibration. KHP, which degrades more slowly, may be used, but is not known to have been tested. Manual calibration checks are recommended monthly, at a minimum, by feeding a glycol calibration standard into the manual sample port. Maintenance or replacement is required annually on the internal pumps.

2. Selection Criteria

Method and Use Status

Parameter	Total organic carbon (TOC).
Type	Online monitor.
Method of Description	UV/ozone oxidation. Ozone with UV light degrade the carbon in the water sample, and the release of carbon dioxide is measured.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 100,000 mg/L TOC (see notes).
Accuracy	±3%.
Response Time	Programmable, 7 min. minimum.
Siting Constraints/Needs	- Potable water. - Electricity. - Temperature-controlled environment.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required.
Interferences	- Chloride (>30%). - Calcium (>12%).
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.

O&M Issues	Replace consumables.
Data Retrieval	Local readout, analog connection, serial port connection.
Recommended Features	Offline manual sample operation (included in standard unit).
Optional Features	- Additional parameters measured (total nitrogen, total phosphorus). - Multi-stream sampling (up to 6 streams). - Digital outputs/contacts.

Typical Costs

Capital Cost	Very high.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Medium.

FACT SHEET 66

Refractometry

1. Description

Analytical Process

This method uses the fact that the speed of light decreases when it passes through denser fluids. This is the reason that objects sticking out of water appear to bend when viewed at an angle.

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample is fed continuously into a cell, and a beam of light is projected through the sample at an angle. Photodetectors are used to measure the angle that the light bends as it passes through the sample. The more dense the solution, the more the light will bend. The result is temperature corrected, and the density of the sample is reported. An additional step can be included in which a correlation is made between densities and concentrations for a reference compound. The reading can then be converted from density to concentration of the compound (i.e., deicer or COD). See Chapter 5 for discussion of correlation to other parameters.

Advantages

Easy to operate.

No reagents are required.

Disadvantages

Poor accuracy for sample streams with low concentrations (<10,000 mg/L BOD).

Frequent cleaning of lens is typical to maintain accuracy.

Filtration maintenance is typical to maintain accuracy.

Notes

Most significant reason for use: fast result and low maintenance.

Most significant reason to avoid: inaccurate at moderate to low concentrations.

Typical equipment includes monitor unit, local controller, and sample loop piping.

Recommended system components include sample shelter.

Typical replacement items: none.

Consumables: none.

Airport users reported this to be an effective, low-maintenance solution for high concentration sample streams (>1% glycol), especially at deicer pad collection or glycol recycling operations.

Commonly used at airports in the preparation and mixing of aircraft deicers.

Manual calibration checks recommended weekly and manual calibrations recommended monthly. Calibration checks can be performed using a handheld refractometer. Annual factory recalibration by the manufacturer is also recommended. Regular maintenance is required for manual cleaning of the optics. Biogrowth may be controlled by injecting low-concentration bleach solution into sample line.

2. Selection Criteria

Method and Use Status

Parameter	BOD/COD/TOC by correlation.
Type	Online monitor.
Method of Description	Refractometry. The refractive index, or light bending property, of the water sample is measured and correlated to a concentration of deicer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, treatment influent.
Regulatory-Approved Method	None reported.
Measurement Range	>1% glycol (approximately 10,000 mg/L BOD).
Accuracy	±1%.
Response Time	Immediate.
Siting Constraints/Needs	- Electricity. - Temperature-controlled environment. - Install perpendicular to a horizontal pipe to keep instrument flooded.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required. - Continuous flow through instrument recommended. - Inline filter to reduce total suspended solids.
Interferences	- Suspended solids. - Chemicals which cause changes in sample density (e.g., salts).

Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Calibrate frequently to minimize drift. - Clean frequently to remove build up of films and dirt on lens.
Data Retrieval	Local readout, analog connection.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 67

Optical/Absorbance

1. Description

Analytical Process

The method is based on the principle that the absorbance of light at a particular wavelength is proportional to the concentration of the compound that is absorbing the light.

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample flows continuously into a cell where a beam of UV and visible light is projected through the sample and a photometer measures the absorbance spectrum. The concentration of deicer is reported based on internal calculations as BOD, COD, or TOC. See Chapter 5 for discussion of correlation to other parameters.

Advantages

No temperature-controlled shelter is required—a canopy is recommended by manufacturer.

No reagents are required.

Automatic cleaning of lens reduces maintenance.

Disadvantages

Local calibration is dependent on constituents and concentrations, which tend to be variable.

Technology should be tested on airport storm water.

Inaccurate at low concentrations because of interference by other chemicals or solids in sample.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: maintenance issues.

Typical equipment includes monitor unit, controller, mounting equipment, and flow cell.

Recommended system components include canopy.

Typical replacement items: none.

Consumables: none.

Glycol has low absorbance properties, so some manufacturers develop a correlation based on other constituents in the deicer.

Regular maintenance is performed to check the automatic cleaning mechanism and to manually clean the optics. Manual calibration checks are recommended monthly, at a minimum. Annual factory recalibration by the manufacturer is also recommended.

Other parameters may be analyzed with the monitor, such as total suspended solids, nitrates, and temperature.

2. Selection Criteria

Method and Use Status

Parameter	BOD/COD/TOC by correlation.
Type	Online monitor.
Method of Description	Optical/absorbance. The absorbance of UV-visible light through the water sample is measured and correlated to a concentration of deicer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 5,000 mg/L COD. (Up to 45,000 mg/L COD with proper configuration.)
Accuracy	±2%.
Response Time	Programmable, 1 min. minimum.
Siting Constraints/Needs	- Electricity. - Compressed air. - Canopy for weather protection.
Flow and Stream Constraints	- Installed submerged in sample stream or in a flow cell. - For gravity storm sewers, a sample pump/sample loop is typically required with flow cell.

Interferences	Application specific, depending on sample stream chemical composition.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Clean frequently to remove buildup of films and dirt on lens. - Check automatic cleaning equipment to maintain accuracy. - Calibration is dependent on concentrations and constituents in sample.
Data Retrieval	Local readout, analog connection.
Recommended Features	Automatic cleaning with compressed air.
Optional Features	- Flow cell. - Additional parameters measured (total suspended solids, temperature). - Serial port connection, digital outputs/ contacts. - USB connection, Ethernet, or cellular communication.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 68

Optical/Absorbance, Reflectance, and Fluorescence

1. Description

Analytical Process

The method is based on the principle that the absorbance, reflectance, and fluorescence of light at a particular wavelength are proportional to the concentration of the compound that is absorbing the light. The unit uses calculation algorithms along with an internal library of reference spectra to calculate the concentration of deicer.

This unit collects a sample from the sample stream continuously and records measurements at a programmable time interval (up to 60 per hour). The sample flows continuously into a cell where a beam of UV and visible light is projected through the sample, and a photometer measures the absorbance, reflectance, and fluorescence. The concentration of deicer is reported based on internal calculations as BOD, COD, or TOC. See Chapter 5 of the guidebook for discussion of correlation to other parameters.

Advantages

No temperature-controlled shelter is required.

No reagents are required.

Real-time and historical data available through web-based user interface.

Automatic cleaning of lens reduces maintenance.

Disadvantages

Local calibration is dependent on constituents and concentrations, which tend to be variable.

Inaccurate at low concentrations because of interference by other chemicals or solids in sample.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: new technology under testing.

Typical equipment includes monitor unit and sample loop piping.

Recommended system components include canopy.

Typical replacement items: none.

Consumables: none.

Technology is currently under testing on airport storm water.

The instrument has an auto-calibration feature, and the recommended frequency is daily. Regular maintenance is performed to check the automatic cleaning mechanism and to manually clean the optics. Manual calibration checks are recommended monthly, at a minimum. Annual factory recalibration by the manufacturer is also recommended.

Other parameters may be analyzed with the monitor, such as total suspended solids, nitrates, temperature, and flow rate.

2. Selection Criteria

Method and Use Status

Parameter	BOD/COD/TOC by correlation.
Type	Online monitor.
Method of Description	Optical/absorbance, reflectance, and fluorescence. The absorbance, reflectance, and fluorescence of UV-visible infrared light through the water sample is measured and correlated to a concentration of deicer.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent. Diversion and collection system monitoring may be limited by the upper range of instrument.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 5,000 mg/L TOC. (Up to 10,000 mg/L TOC with proper configuration.)
Accuracy	±3%.
Response Time	Programmable, 2 min. minimum.
Siting Constraints/Needs	- Potable water. - Electricity.

Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required. - Continuous flow through instrument recommended. - Inline filter (if sand and grit are present).
Interferences	Application specific, depending on sample stream chemical composition.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Clean frequently to remove buildup of films and dirt on lens. - Check automatic cleaning equipment to maintain accuracy. - Calibration is dependent on concentrations and constituents in sample.
Data Retrieval	Local readout, analog connection, web interface, USB connection, Ethernet connection, cellular communications.
Recommended Features	None.
Optional Features	- Additional parameters measured (TSS, temperature, nitrate). - Dual stream sampling.

Typical Costs

Capital Cost	Very high.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Medium.

FACT SHEET 69

Refractometry

1. Description

Analytical Process

This method uses the fact that the speed of light decreases when it passes through denser fluids. This is the reason that objects sticking out of water appear to bend when viewed at an angle.

A drop of sample is placed on the instrument sample platform. A beam of light is projected through the sample at an angle. Photodetectors are used to measure the angle that the light bends as it passes through the sample. The more dense the solution, the more the light will bend. The result is temperature corrected, and the density of the sample is reported. An additional step can be included in which a correlation is made between densities and concentrations for a reference compound. The reading can then be converted from density to concentration of the compound (i.e., deicer or COD). See Chapter 5 for discussion of correlation to other parameters.

Advantages

Easy to operate.

No reagents are required.

Disadvantages

Poor accuracy for sample streams with low concentrations (<10,000 mg/L BOD).

Lens must be frequently cleaned to maintain accuracy.

Filtration maintenance is typical to maintain accuracy.

Notes

Most significant reason for use: fast result.

Most significant reason to avoid: inaccurate at moderate to low concentrations.

Typical equipment includes: monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Airport users reported this to be an effective, low-maintenance solution for high-concentration sample streams (>1% glycol), especially at deicer pad collection or glycol recycling operations.

Commonly used at airports in the preparation and mixing of aircraft deicers.

Manual calibration checks are recommended weekly and manual calibrations are recommended monthly. Handheld unit can be used to check calibration of an online refractometer.

2. Selection Criteria

Method and Use Status

Parameter	BOD/COD/TOC by correlation.
Type	Handheld monitor.
Method of Description	Refractometry The refractive index, or light bending property, of a water sample is measured and correlated to a concentration of deicer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	>1% glycol (approximately 10,000 mg/L BOD).
Accuracy	±1%.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Suspended solids. - Chemicals that cause changes in sample density (e.g., salts).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	Calibrate frequently to minimize drift.
Data Retrieval	Local readout.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 70

Colorimetric (EG in Water)

1. Description

Analytical Process

A sample is collected and placed in a reaction vial. An oxidant (periodic acid) and an indicator compound (purpald) are added. The oxidant converts the ethylene glycol and/or propylene glycol to formaldehyde, which reacts with indicator compound. The color of the sample is then compared to a color chart or measured using a photometer.

Advantages

Correction factors are defined to convert test results when measuring propylene glycol.

Good for screening water quality.

Disadvantages

Data is qualitative (i.e., reported as a range rather than a specific value).

Notes

Most significant reason for use: indicator for presence/absence of ADF.

Most significant reason to avoid: not a qualitative method (does not give a concentration).

Typical equipment includes reaction vials and color comparator or photometer.

Recommended system components: none.

Typical replacement items include photometer light source.

Consumables include reagents.

This test was developed for testing boiler water, and interferences from storm water may not be completely known. Ranges for the color comparison test kits are 1–15 mg/L ethylene glycol or 1,000–15,000 mg/L. Ranges when using the photometer are 0.6–10 mg/L ethylene glycol or 5–65 mg/L propylene glycol.

Consumables include reagents for test and have a shelf life of 5 months.

Visual comparisons do not have a calibration step. When a photometer is used for the measurement, a blank solution is used to zero photometer during each visual test. The photometer has internal calibration software that can be updated by downloading the program from the manufacturer’s website. It is recommended that personnel check for calibration updates approximately every 6 months.

2. Selection Criteria

Method and Use Status

Parameter	BOD/COD/TOC by correlation.
Type	Test kit.
Method of Description	Colorimetric (EG in water). Periodic acid [iodic(VII) acid] oxidizes glycol to formaldehyde, which then reacts with chemical (purpald) in a basic solution (high pH) to form a purple-colored complex. The glycol concentration is determined by comparison of the sample to a color chart.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	1 to 15,000 mg/L glycol.
Accuracy	½ to 1 color standard increment. (Concentration is read as a range.)
Response Time	Immediate to 2 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Test does not differentiate between propylene glycol or ethylene glycol. - Extreme high or low temperatures. - Strong oxidizers or aldehydes. - Low pH samples (pH < 4). - High dissolved solids (>700 mg/L).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- 5 month chemical shelf life. - Kits should be stored in the dark. - Not applicable for sea water samples.
Data Retrieval	Visual; serial port connection.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 71

Colorimetric

1. Description

Analytical Process

The instrument collects a sample from a continuous sample loop at a programmable time interval (up to 6 per hour). The sample loop contains a filter for the sample. The sample is fed into a reaction chamber and combined with hypochlorite and phenol catalyzed by (typically) manganese. The reaction produces a compound with a bright blue color (indophenols) with a maximum light absorbance at a wavelength of 630 nm. The measurement is reported as ammonia–nitrogen.

Advantages

Low detection limit.

Automatic cleaning and calibration.

Disadvantages

Long calibration and cleaning times, up to 45 min.

Several potential types of interferences.

Notes

Most significant reason for use: diversion of storm water for ammonia.

Most significant reason to avoid: maintenance on online monitor.

Typical equipment includes sample collector, filtration components, and monitor unit.

Recommended system components include cleaning system and sample shelter.

Typical replacement items include internal pumps.

Consumables include sample and internal tubing, filtration membrane, and reagents

Colorimetric methods include phenate and salicylate methods that form colored complexes.

Samples with high alkalinity and hardness can be treated with citrate to prevent clouding of solution. If sulfide interferences occur, they can be removed by reducing pH. Turbidity interferences can be removed by filtering samples

Mercuric chloride, which has been used for sample preservation, should be avoided because of chloride interference and mercury disposal issues.

Start-up requires installation of sample and reagent tubing and filling reagent vessels. Instruments have an auto-calibration feature, and the recommended frequency is daily. Calibration checks are recommended weekly, at a minimum. Reagents should be replaced monthly. Tubing should be checked weekly, and typically tubing is replaced approximately every 6 months.

2. Selection Criteria

Method and Use Status

Parameter	Ammonia (NH_3-N).
Type	Online monitor.
Method of Description	Colorimetric. Ammonia reacts with hypochlorite and other reagents to produce an intense blue complex (phenate method) or green complex (salicylate method). The ammonia concentration is determined by measuring the light intensity of the sample using a colorimeter, photometer, or spectrophotometer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 350.1).
Measurement Range	1 µg/L to 400 mg/L.
Accuracy	±2% of full range value.
Response Time	15 min.
Siting Constraints/Needs	- Electricity. - Temperature-controlled environment. - Water connection or air compressor for cleaning.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required. - Minimal sample/stream flow is necessary for equipment to operate. - Standby feature.
Interferences	- Chloride. - Calcium and magnesium (1,500–2,500 mg/L).

	- Nitrate/nitrite (30–250 mg/L). - Turbid or strongly acidic/alkaline samples (pH < 3 or > 12). - Sulfides (300 mg/L). - Grease/oils.
Staff Time Requirements	High.
Level of Staff Knowledge	High.
O&M Issues	- Weekly maintenance/calibration. - Biannual maintenance. - Potential tubing clogging. - Replace tubing annually.
Data Retrieval	Local readout, analog connection, Ethernet.
Recommended Features	- Pre-filtration of samples. - Cleaning system.
Optional Features	- Pre-filtration of samples. - Cleaning system. - Monitor unit can typically monitor for additional parameters (e.g., temperature, nitrate, pH). - System alarms.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	Medium.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 72

Ultraviolet Absorbance

1. Description

Analytical Process

The method is based on the principle that the absorbance of light at a particular wavelength is proportional to the concentration of the compound that is absorbing the light.

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample flows continuously into a cell where a beam of UV light is projected through the sample and a photometer measures the absorbance spectrum. The concentration is reported as ammonia–nitrogen.

Advantages

Automatic cleaning and calibration.

Inexpensive reagents needed for system.

Disadvantages

Biofouling of flow cell may affect reading.

Notes

Most significant reason for use: diversion of storm water for ammonia.

Most significant reason to avoid: maintenance on online monitor.

Typical equipment includes sample collector, filtration components, and monitor unit.

Recommended system components include cleaning system and sample shelter.

Typical replacement items include battery and lamp.

Consumables include filtration membrane and reagents.

Startup requires installation of sample and reagent tubing and filling reagent vessels. Instruments have an auto-calibration feature, and the recommended frequency is daily. Calibration checks are recommended weekly, at a minimum. Tubing is recommended to be checked weekly. Cleaning and zeroing solutions should be replenished weekly. Reagent chemicals should be replaced monthly. Battery and lamp may need replacement every 2 years.

Shutdown is recommended if analyzer is not in use for 2 to 3 days. Reagents should be removed and covered, and the system should be flushed.

2. Selection Criteria

Method and Use Status

Parameter	Ammonia (NH_3-N).
Type	Online monitor.
Method of Description	Optical/absorbance. Ammonia reacts with hypochlorite and other reagents to produce an intense blue complex (phenate method) or green complex (salicylate method). The ammonia concentration is determined by measuring the ultraviolet light intensity of the sample using a colorimeter, photometer, or spectrophotometer.
Level of Technology Development	Evolving.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0.02 to 5 mg/L.
Accuracy	2–5% of full range value.
Response Time	10 min.
Siting Constraints/Needs	- Electricity. - Temperature-controlled environment. - Sample collection line to analyzer. - Sample waste discharge.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/sample loop is typically required. - Two sample connections. - Higher flows needed for equipment to operate compared to colorimetric analyzers (0.5–5 l/min). - Standby feature.
Interferences	- Solids/turbid samples (max. 150 mg/L or 60 NTU). - Organic matter. - Grease/oils.
Staff Time Requirements	High.
Level of Staff Knowledge	High.

O&M Issues	- Potential clogging of tubing if solids criteria are exceeded. - Weekly reagent refill.
Data Retrieval	Local readout, serial port connection.
Recommended Features	Two forms of ammonia can be monitored (e.g., total ammonia and free ammonia).
Optional Features	- Service/maintenance alarms. - Pre-filtration of samples.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	Medium.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 73

Ammonia Selective Electrode

1. Description

Analytical Process

The ion selective probe is placed in the sample stream. Ammonia passes through the gas-permeable membrane proportional to the concentration. In the thin film between the membrane and a pH glass electrode, the ammonia causes a pH change. The change in pH is reported as ammonia–nitrogen.

Advantages

Quick response time.

In-stream measurement.

Disadvantages

Biofouling of membrane may affect reading.

Rupture of membrane will give inaccurate readings.

Notes

Most significant reason for use: diversion of storm water and less maintenance that other online monitors.

Most significant reason to avoid: maintenance of in-stream probe.

Typical equipment includes electrode and monitor unit.

Recommended system components include cleaning system.

Typical replacement items: none.

Consumables include electrode membrane, reagents (for "known addition" method) or filling solution, and tubing.

Startup requires installing electrode membrane, filling electrode with filling solution, and connecting to analyzer module. Installation of sample and reagent tubing is necessary for "known addition" method. Instruments have auto-calibration feature with a typical frequency of several hours. Calibration checks are recommended daily, at a minimum. Checks of tubing and replenishing reagent solutions for "known addition" method are recommended weekly. Electrode membranes are typically replaced every 6 months to annually.

When a probe is temporarily not in use (i.e., out of service less than 1 week) it should be rinsed and stored in a standard solution. If probe is not in use for more than 1 week, the membrane should be removed, and it should be disassembled and stored for future use.

2. Selection Criteria

Method and Use Status

Parameter	Ammonia (NH_3-N).
Type	Online monitor.
Method of Description	Ammonia selective electrode. Ammonia measurement is made using an ion-selective, gas permeable membrane. Ammonia diffuses through the membrane and alters the ability of an internal electrode solution to conduct electricity. The change in conductance is proportional to the ammonia concentration in solution.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 350.3).
Measurement Range	0.1 to 1,000 mg/L.
Accuracy	±2% of full range value.
Response Time	Immediate to 2 min.
Siting Constraints/Needs	- Structure needed to mount probe (e.g., culvert, storm sewer). - Electricity. - Temperature-controlled environment. - Connection to air compressor for cleaning.
Flow and Stream Constraints	- Installed submerged in sample stream. - Flow is necessary for equipment to operate.
Interferences	- Amines. - Mercury. - Silver. - Potassium. - Grease/oil. - Large changes in ionic strength.
Staff Time Requirements	Medium.
Level of Staff Knowledge	Moderate.
O&M Issues	- 6-month membrane life. - Periodically refill electrode.

	- Store electrode in ammonia storage solution when not in use. - Potential clogging of tubing.
Data Retrieval	Local readout, USB connection, Ethernet, serial port connection.
Recommended Features	Cleaning system.
Optional Features	- Probes that compensate for potassium interference. - SCADA system integration. - Alarms. - Cleaning system. - Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, nitrate, pH). - Use "known addition" instruments to measure low concentrations of ammonia.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	Medium.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 74

Ammonia Selective Electrode

1. Description

Analytical Process

The ion selective probe is placed in the sample stream. Ammonia passes through the gas-permeable membrane proportional to the concentration. In the thin film between the membrane and a pH glass electrode, the ammonia causes a pH change. The change in pH is reported as ammonia–nitrogen.

Advantages

Quick response time.

Disadvantages

Rupture of membrane will give inaccurate readings.

Notes

Most significant reason for use: easy to operate.

Most significant reason to avoid: maintenance of handheld probe.

Typical equipment includes electrode and monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables include electrode membrane and filling solution.

Startup requires installing electrode membrane, filling electrode with filling solution, and connecting to analyzer module. Calibration checks are recommended daily, at a minimum. Replenishing internal filling solution is recommended, when the probe won't calibrate. Electrode membranes are typically replaced every 6 months to annually, depending on use.

When probe is temporarily not in use (i.e., out of service less than 1 week) it should be rinsed and stored in a standard solution. If probe is not in use for more than 1 week, the membrane should be removed, and it should be disassembled and stored for future use.

2. Selection Criteria

Method and Use Status

Parameter	Ammonia (NH_3-N).
Type	Handheld monitor.
Method of Description	Ammonia selective electrode. Ammonia measurement is made using an ion-selective, gas permeable membrane. Ammonia diffuses through the membrane and alters the ability of an internal electrode solution to conduct electricity. The change in conductance is proportional to the ammonia concentration in solution.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 350.3).
Measurement Range	2 to 200 mg/L.
Accuracy	±10% of measured value.
Response Time	Immediate to 2 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	- Sufficient depth for probe immersion.
Interferences	- Amines. - Mercury. - Silver. - Potassium. - Grease/oil. - Large changes in ionic strength.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- 6-month membrane life. - Calibrate using known ammonia concentration solutions. - Periodically refill electrode. - Electrode must be rinsed before measuring ammonia. - Store electrode in ammonia storage solution when not in use.
Data Retrieval	Local readout.

Recommended Features	- Storage solution for probe. - Replaceable probe.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, nitrate, pH).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 75

Colorimetric

1. Description

Analytical Process

A sample is collected and pipetted into a reaction vial containing hypochlorite and phenol catalyzed by (typically) manganese. The reaction produces a compound with a bright blue color (indophenols) with a maximum light absorbance at a wavelength of 630 nm. The color intensity is measured using a photometer, colorimeter, or spectrophotometer. The measurement is reported as ammonia–nitrogen.

Advantages

Little sample is needed to perform test.

Disadvantages

Several potential types of interferences.

Notes

Most significant reason for use: relatively easy to perform in on-site lab.

Most significant reason to avoid: uses chemical reagents.

Typical equipment includes reaction vials, pipettes, and a spectrophotometer/colorimeter/photometer.

Recommended system components: none.

Typical replacement items include lamp for spectrophotometer/colorimeter/photometer.

Consumables include reagents.

Colorimetric methods include phenate and salicylate methods to form colored complexes.

Samples with high alkalinity and hardness can be treated with citrate to prevent clouding of solution.

If sulfide interferences occur, they can be removed by reducing pH. Turbidity interferences can be removed by filtering samples.

Mercuric chloride, which has been used for sample preservation, should be avoided because of chloride interference and mercury disposal issues.

Check accuracy of method by creating a standard curve of known glycol concentrations. Use blank solutions to zero equipment during each test. Recommend performing standard curve checks weekly or monthly.

Replace standard solutions every 90 days to 6 months.

2. Selection Criteria

Method and Use Status

Parameter	Ammonia (NH_3-N).
Type	Test kit.
Method of Description	Colorimetric. Ammonia reacts with hypochlorite and other reagents to produce an intense blue complex (phenate method) or green complex (salicylate method). The ammonia concentration is determined by measuring the light intensity of the sample using a colorimeter, photometer, or spectrophotometer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	0.01 to 50 mg/L.
Accuracy	±4% of full range.
Response Time	15 min.
Siting Constraints/Needs	None known.
Flow and Stream Constraints	N/A.
Interferences	- Chloride. - Calcium (>50,000 mg/L) and magnesium (>300,000 mg/L). - Nitrate/nitrite (600–5,000 mg/L). - Turbid or strongly acidic/alkaline samples. - Sulfides (>6,000 mg/L). - Orthophosphate (>5,000 mg/L).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.

O&M Issues	None known.
Data Retrieval	Visual; local readout.
Recommended Features	N/A.
Optional Features	N/A.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 76

Glass Electrode

1. Description

Analytical Process

The probe is immersed in the flow stream. The probe compares the hydrogen ion concentration of the sample to a reference solution inside the probe. Between the sample and the reference solution is a glass layer sandwiched between hydrated gel layers. When there is a difference in the hydrogen ion concentration, an electrical potential is created. The resulting voltage is measured, corrected for temperature, and read as the pH value.

Advantages

Simple operation.

Disadvantages

Increased calibration is typically needed for low pH streams/samples.

Biofouling on probe may affect reading.

Probe may not calibrate or will give erratic readings if it dries out.

Notes

Most significant reason for use: diversion of storm water for pH.

Most significant reason to avoid: maintenance of in-stream probe.

Typical equipment includes pH electrode (probe) and monitor unit.

Recommended system components include cleaning system.

Typical replacement items include probe.

Consumables include reference solution and calibration buffers.

Probe must be kept submerged in solution to avoid drying out.

Probes are typically calibrated daily using two or three buffers with known pH (values of 3, 7, and 10).

Replace junctions (i.e., salt bridge) for combination electrodes every few months to increase equipment life. Reference electrodes are filled with gel or liquid reference solution. Probes may need to be replaced every 6 months to annually. Probe cannot be mounted horizontally. A sodium error that occurs at pH values greater than 10 can be reduced or eliminated by using a low-sodium-error electrode.

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Online monitor.
Method of Description	Glass electrode. Measurement of the hydrogen ion concentration in a sample using the electrical potential difference between a hydrogen ion-sensitive electrode and reference electrode.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 150.2).
Measurement Range	0 to 14.
Accuracy	±0.2 standard units.
Response Time	Several seconds to 1 min.
Siting Constraints/Needs	- Structure needed to mount probe (e.g., culvert, storm sewer). - Electricity. - Water connection or air compressor for cleaning.
Flow and Stream Constraints	Installed submerged in sample stream. Must remain submerged at all times.
Interferences	- Minor interferences from lithium, sodium and potassium. - Highly acidic solutions can affect probe due to acid stripping (pH < 1).
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	- Care must be taken when using glass electrodes to prevent breakage. - Frequent calibration using known buffer solutions. - Electrode must be kept submerged when not in use to prevent dehydration.
Data Retrieval	Analog connection, USB connection, telephone connection, wireless connection, cellular communication.

Recommended Features	- Analyzer with internal adjustment for temperature. - Cleaning system if sample stream is slow moving.
Optional Features	- Automatic cleaning and calibration. - Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, DO).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 77

Glass Free

1. Description

Analytical Process

The probe is immersed in the flow stream. The probe, referred to as an ion-selective field affect transistor (ISFET), is made up of two semiconductors with a gate between them. The gate is sensitive to pH. The flow of electrical current between the semiconductors through the gate is related to the sample pH. When the probe is immersed in a sample, the resulting current between the semiconductors is measured, corrected for temperature, and read as the pH value.

Advantages

Less likely to break compared to glass electrodes.

Additional mounting and placement options available for probe.

Long shelf life and calibration intervals.

Can be stored dry, but not for excessive amounts of time.

Disadvantages

May be too specialized for airport needs.

Typically needs manufacturer-specific analyzer and probe.

Semiconductor is sensitive to light.

Biofouling on probe may affect reading.

Notes

Most significant reason for use: diversion of storm water for pH.

Most significant reason to avoid: maintenance of in-stream probe and expensive probe.

Typical equipment includes pH electrode (probe) and monitor unit.

Recommended system components include cleaning system.

Typical replacement items include probe.

Consumables include calibration buffers.

Non-glass probes are typically used in the food processing industry.

Probes are typically calibrated daily using two or three buffers with known pH (values of 3, 7, and 10).

Probes typically have longer life compared to glass electrodes due to breakage. Probes may need replacement after 18 months.

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Online monitor.
Method of Description	Glass free. Measurement of the hydrogen ion concentration in a sample using the electrical potential between two semiconductors (source and drain electrodes) on either side of an ion-sensitive electrode (gate electrode). Also known as ISFET technology.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Few manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0–14.
Accuracy	±0.2%.
Response Time	Several seconds to 1 min.
Siting Constraints/Needs	- Structure needed to mount probe (e.g., culvert, storm sewer). - Electricity. - Water connection or air compressor for cleaning.
Flow and Stream Constraints	Typically not intended for continuous online use.
Interferences	Minor interferences from highly acidic or basic solutions.
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.

O&M Issues	- Reference electrode is sealed and cannot be refilled, which results in probe replacement when calibration cannot be maintained. - Periodic calibration using known buffer solutions. - Clean electrode periodically using soap/detergent.
Data Retrieval	Analog connection.
Recommended Features	Cleaning system if sample stream is slow moving.
Optional Features	- Automatic cleaning and calibration. - Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, DO).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 78

Glass Electrode

1. Description

Analytical Process

The probe is immersed in the flow stream. The probe compares the hydrogen ion concentration of the sample to a reference solution inside the probe. Between the sample and the reference solution is a glass layer sandwiched between hydrated gel layers. When there is a difference in the hydrogen ion concentration, an electrical potential is created. The resulting voltage is measured, corrected for temperature, and read as the pH value.

Advantages

Simple operation.

Familiar to most individuals.

Disadvantages

Biofouling on probe may affect reading.

Probe may not calibrate or will give erratic readings if it dries out.

Notes

Most significant reason for use: most standard method for pH measurement.

Most significant reason to avoid: maintenance of handheld probe.

Typical equipment includes pH electrode (probe) and monitor unit.

Recommended system components: none.

Typical replacement items include probe.

Consumables include reference solution and calibration buffers.

Probes are typically calibrated daily using two or three buffers with known pH (values of 3, 7, and 10). If probe cannot be calibrated, it is typically replaced. Normal replacement is every 6 months to annually.

Reference electrode may be filled with gel or liquid reference solution.

Some manufacturers report that they have probes that do not require being submerged in solution, but it is recommended that probes remain submerged to extend life and avoid drying out.

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Handheld monitor.
Method of Description	Glass electrode. Measurement of the hydrogen ion concentration in a sample using the electrical potential difference between a hydrogen ion-sensitive electrode and reference electrode.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 150.1).
Measurement Range	0 to 14.
Accuracy	±0.02 standard units (typical).
Response Time	Several seconds to 1 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for probe immersion.
Interferences	- Minor interferences from lithium, sodium, and potassium. - Highly acidic solutions can affect probe due to acid stripping (pH < 1).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	Electrode must be rinsed before measuring pH.
Data Retrieval	Local readout.
Recommended Features	Internal adjustment for temperature.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, DO).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 79

Glass Free

1. Description

Analytical Process

The probe is immersed in the flow stream. The probe, referred to as an ion-selective field affect transistor (ISFET), is made up of two semiconductors with a gate between them. The gate is sensitive to pH. The flow of electrical current between the semiconductors through the gate is related to the sample pH. When the probe is immersed in a sample, the resulting current between the semiconductors is measured, corrected for temperature, and read as the pH value.

Advantages

Less likely to break compared to glass electrodes.

Long shelf life and calibration intervals.

Can be stored dry, but not for excessive amounts of time.

Disadvantages

May be too specialized for airport needs.

Typically needs manufacturer-specific analyzer and probe.

Semiconductor is sensitive to light.

Biofouling on probe may affect reading.

Notes

Most significant reason for use: need for a more robust probe than typical

Most significant reason to avoid: expense of probe.

Typical equipment includes pH electrode (probe) and monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables include calibration buffers.

Non-glass probes are typically used in the food processing industry.

Probes are typically calibrated daily using two or three buffers with known pH (values of 3, 7, and 10). If probe cannot be calibrated, it is typically replaced. Normal replacement is every 6 months to annually.

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Handheld monitor.
Method of Description	Glass free. Measurement of the hydrogen ion concentration in a sample using the electrical potential between two semiconductors (source and drain electrodes) on either side of an ion-sensitive electrode (gate electrode). Also known as ISFET technology.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 14.
Accuracy	±0.01 standard units (typical).
Response Time	Several seconds to 1 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for probe immersion.
Interferences	Minor interferences from highly acidic or basic solutions.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Reference electrode is sealed and cannot be refilled, which results in probe replacement when calibration cannot be maintained. - Periodic calibration using known buffer solutions. - Clean electrode periodically using soap/detergent.
Data Retrieval	Local readout.
Recommended Features	None known.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 80

Test Strips

1. Description

Analytical Process

The test strip is immersed in the sample for several seconds. An indicator compound in the pad at the end of the test strip reacts with the hydrogen ions in the sample and changes color. The color of the test strip is then compared to a color chart to determine the range of the pH value.

Advantages

Good for water quality screening.

Very easy to use.

Disadvantages

Data is qualitative (i.e., reported as a range rather than a specific value).

Test strips typically have a shelf life up to 5 years.

Notes

Most significant reason for use: quick check for internal use.

Most significant reason to avoid: not acceptable for compliance.

Typical equipment includes test strips.

Recommended system components: none.

Typical replacement items: none.

Consumables include test strips.

This method consists of determining pH using disposable test strips.

Test strips do not require calibration.

Test strips should be disposed of if compromised (i.e., exposed to water or past expiration date).

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Test kit.
Method of Description	Test strips. Test strips contain an indicator that changes color when immersed in a sample. The pH value is determined by comparing the color of the test strip to a color chart.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	4–10 (typical).
Accuracy	±0.2–1.0 standard units.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	High concentrations of chlorine or bromine.
Interferences	High concentrations of chlorine or bromine.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	None known.
Data Retrieval	Visual.
Recommended Features	N/A.
Optional Features	N/A.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 81

Colorimetric

1. Description

Analytical Process

A sample is collected into a sample vial and a few drops of an indicator compound are added. The sample is mixed, and the indicator compound reacts, creating a color change. The color of the sample is then compared to a standard color chart or measured using a colorimeter to determine the pH value.

Advantages

Easy to use.

Disadvantages

Data range is limited, but typically within airport storm water concentrations.

Notes

Most significant reason for use: quick check for internal use.

Most significant reason to avoid: uses chemical reagents.

Typical equipment includes sample tube and color comparator or colorimeter.

Recommended system components: none.

Typical replacement items include bulb for colorimeter.

Consumables include reagents and pH standards.

Visual tests are not calibrated. Use blank solutions to zero colorimeter or during each visual test. Check accuracy of method by performing test with solutions of known pH. Recommend checking accuracy weekly or monthly.

Replace standard solutions every 90 days to 6 months.

2. Selection Criteria

Method and Use Status

Parameter	pH.
Type	Test kit.
Method of Description	Colorimetric. Absorbance of a sample is measured after adding a known amount of phenol red indicator. The measured absorbance corresponds to the pH value.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	5.9–8.5.
Accuracy	±0.1 standard units.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	N/A.
Interferences	Chlorine (>6 mg/L).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic battery and light source replacement. - Periodic calibration.
Data Retrieval	Local readout.
Recommended Features	N/A.
Optional Features	Colorimeter can typically test for additional parameters (e.g., ammonia, COD).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 82

Amperometric/Polarographic Sensor

1. Description

Analytical Process

The probe is placed in the sample stream. Dissolved oxygen (DO) passes through a membrane (typically Teflon) and into a fluid adjacent to a pair of electrodes. A potential difference is created between the electrodes, and the dissolved oxygen is reduced at the working electrode. The limiting current is proportional to the concentration of DO.

Advantages

Good for severe fouling environments.

Automatic cleaning and calibration.

Disadvantages

Membrane replacement can be difficult.

Biofouling of probe can affect reading.

Notes

Most significant reason for use: diversion of storm water for DO or requirement for continuous measurement.

Most significant reason to avoid: maintenance of in-stream probe.

Typical equipment includes DO probe and monitor unit.

Recommended system components: none.

Typical replacement items include DO probe.

Consumables include DO probe membrane and electrolyte solution.

Probes analyze for low-, medium-, and high-range DO.

Probes should be installed in sample stream for several hours prior to calibration to reach equilibrium. Instruments have an auto-calibration feature, and the recommended frequency is daily. Probes can also be calibrated in DO-saturated solution or air. Weekly calibration checks are recommended, at a minimum. Probes can be zeroed using nitrogen gas or sodium sulfate solution.

Probe membrane should be cleaned weekly. When probe is not in use, it should be rinsed and stored in water to prevent drying out. Replace membrane and electrolyte every month to annually, depending on use. The average life of a probe is several years.

Monitors can also be configured as submerged data sondes.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Online monitor.
Method of Description	Amperometric/polarographic sensor. The dissolved oxygen of a sample is measured using a gas-permeable, membrane-covered electrode with an amperometric/polarographic sensor.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 360.1).
Measurement Range	0.01–80 mg/L (typical maximum necessary for water is 15–20 mg/L).
Accuracy	±1%.
Response Time	Several seconds.
Siting Constraints/Needs	- Structure needed to mount probe; probe must be mounted upright. - Electricity. - Shelter for weather protection of analyzer. - Connection to water or air compressor for cleaning.
Flow and Stream Constraints	- Installed submerged in sample stream. Must remain submerged at all times. - Flow is necessary for accurate reading.
Interferences	- Dissolved inorganic salts. - Reactive compounds/gases (e.g., Cl_2, H_2S). - Temperature sensitive.
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	- Periodic membrane replacement. - Susceptible to biofouling. - Refilling of electrode solution is necessary.
Data Retrieval	Analog connection, USB connection, datalogger.
Recommended Features	Cleaning system.

Optional Features	- Automatic cleaning and calibration. - Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, pH, TSS). - Service/maintenance alarms. - Ball/float mounting systems available.

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 83

Optical/Fluorescence Sensor

1. Description

Analytical Process

The probe is placed in the sample stream. A fluorescent film on the surface of the probe is exposed to light. The fluorescent compound shines following removal of the light; however, dissolved oxygen in the water colliding with the film shortens the duration of the fluorescence. The length of time that the fluorescence is shortened is proportional to the concentration of DO.

Advantages

Chemicals and membranes are not necessary.

Less frequent calibration and sensor replacement than amperometric/polarographic method.

Disadvantages

Biofouling can affect reading.

Notes

Most significant reasons for use: diversion of storm water for DO or requirement for continuous measurement.

Most significant reason to avoid: maintenance of in-stream probe, but less maintenance than amperometric/polarographic sensor.

Typical equipment includes DO probe and monitor unit.

Recommended system components include cleaning system.

Typical replacement items include DO probe.

Consumables include sensor cap (some models).

Probes are calibrated in saturated solution or air. Calibration checks are recommended weekly, at a minimum. Probes can be zeroed using nitrogen gas or sodium sulfate solution. Probes must be submerged in solution.

Probe sensor should be manually cleaned weekly, and frequently by an automatic wiper system. When probe is not in use, it should be rinsed and stored in water to avoid drying out. The average life of a probe is several years. For the models that have sensor caps, they are typically replaced every 30 to 90 days.

Monitors can also be configured as submerged data sondes.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Online monitor.
Method of Description	Optical/fluorescence sensor. A light source excites an oxygen-permeable, luminescent/fluorescent material in contact with the sample. The light source is turned off and the material fluoresces (gives off light). Dissolved oxygen in the sample changes the amount of light given off, and the difference is read by a light sensor.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	(EPA has approved use, but method number is not available. It is likely the method will be 360.3).
Measurement Range	2 μg/L to 20 mg/L.
Accuracy	±1 to 15%.
Response Time	Several seconds.
Siting Constraints/Needs	- Structure needed to mount probe, probe must be mounted upright. - Electricity. - Shelter for weather protection of analyzer. - Connection to water or air compressor for cleaning.
Flow and Stream Constraints	- Installed submerged in sample stream. - Flow is necessary for equipment to operate.
Interferences	Air bubbles.
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	- Calibration. - Membrane replacement. - Susceptible to biofouling.
Data Retrieval	Analog connection, USB connection, Ethernet, wireless communication.

Recommended Features	- Automatic calibration. - Service/maintenance alarms. - Cleaning system.
Optional Features	- Cleaning system. - Automatic calibration. - Service/maintenance alarms. - Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, pH).

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 84

Amperometric/Polarographic Sensor

1. Description

Analytical Process

The probe is placed in the sample stream. DO passes through a membrane (typically Teflon) and into a fluid adjacent to a pair of electrodes. A potential difference is created between the electrodes, and the dissolved oxygen is reduced at the working electrode. The limiting current is proportional to the concentration of DO.

Advantages

Fewer potential interferences than the alternative method (Winkler titration method).

Disadvantages

Membrane replacement can be difficult.

Notes

Most significant reason for use: typical method for DO measurement.

Most significant reason to avoid: maintenance of handheld probe.

Typical equipment includes DO probe and monitor unit.

Recommended system components: none.

Typical replacement items include DO probe.

Consumables include DO probe membrane and electrolyte solution.

Probes are typically calibrated daily. Probes are calibrated in saturated DO solution or air. If probe cannot be calibrated, it is typically replaced. Normal replacement is every 6 months to annually. Probes can be zeroed using nitrogen gas or sodium sulfate solution.

Probe membrane should be cleaned weekly. When probe is not in use, it should be rinsed and stored in water solution to avoid drying out. Replace membrane and electrolyte every month to annually, depending on use. The average life of a probe is several years.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Handheld monitor.
Method of Description	Amperometric/polarographic sensor. The dissolved oxygen of a sample is measured using a gas-permeable, membrane-covered electrode with an amperometric/polarographic sensor.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 360.1).
Measurement Range	0 to 50 mg/L (typical maximum necessary for water is 15–20 mg/L).
Accuracy	±1.5 to 15%.
Response Time	Several seconds.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for installation of a probe.
Interferences	- Dissolved inorganic salts. - Reactive Compounds/Gases (e.g., Cl_2, H_2S). - Temperature sensitive.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic membrane replacement. - Refilling of electrode solution is necessary.
Data Retrieval	Local readout.
Recommended Features	- Installed submerged in sample stream. - Flow is necessary for equipment to operate.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., temperature, conductivity, pH).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 85

Optical/Fluorescence Sensor

1. Description

Analytical Process

The probe is placed in the sample stream. A fluorescent film on the surface of the probe is exposed to light. The fluorescent compound shines following removal of the light; however, dissolved oxygen in the water colliding with the film shortens the duration of the fluorescence. The length of time that the fluorescence is shortened is proportional to the concentration of DO.

Advantages

Chemical and membranes are not necessary.

Less frequent calibration and sensor replacement than amperometric/polarographic method.

Monitor unit can monitor additional parameters (e.g., temperature).

Disadvantages

Bright sunlight may affect reading.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: maintenance of handheld probe, but less maintenance than amperometric/polarographic sensor.

Typical equipment includes DO probe and monitor unit.

Recommended system components: none.

Typical replacement items include sensor cap.

Consumables: none.

Probes are calibrated in saturated DO solution or air. Calibration checks are recommended monthly, but may be able to be completed every several months. Probes can be zeroed using nitrogen gas or sodium sulfate solution.

Probe sensor should be cleaned weekly. Sensor cap needs to be replaced annually. When probe is not in use, it should be rinsed and stored in water to avoid drying out. The average life of a probe is several years.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Handheld monitor.
Method of Description	Optical/fluorescence sensor. A light source excites an oxygen-permeable, luminescent/fluorescent material in contact with the sample. The light source is turned off and the material fluoresces (gives off light). Dissolved oxygen in the sample changes the amount of light given off, and the difference is read by a light sensor.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	(EPA has approved use, but method number is not available. It is likely the method will be 360.3.)
Measurement Range	0 to 50 mg/L (typical maximum necessary for water is 15–20 mg/L).
Accuracy	±1 to 15%.
Response Time	Several seconds.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for installation of a probe.
Interferences	Air bubbles.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Calibration. - Membrane replacement.
Data Retrieval	Local readout.
Recommended Features	N/A.
Optional Features	None known.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 86

Winkler Titration

1. Description

Analytical Process

A sample bottle is filled completely with water so that no air bubbles are included. Manganese sulfate, alkali-iodide-azide reagent, and sulfuric acid are added to the sample and mixed. The sample is then titrated to two different end points with sodium thiosulfate. The amount of sodium thiosulfate required to reach the titration endpoint is proportional to the DO concentration.

Advantages

Very accurate in the absence of interferences.

Disadvantages

Limited range in DO measurement.

Requires reagents and titration typically.

Titrating past end point can produce erroneous results.

Notes

Most significant reason for use: none.

Most significant reason to avoid: complexity of method.

Typical equipment includes: titration apparatus.

Recommended system components: none.

Typical replacement items: none.

Consumables include reagents.

Analysis must be performed immediately upon sample collection or within 45 min. Do not allow the sample to become agitated.

This method does not require calibration.

Shelf life of reagents is approximately 1 to 2 years.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Test kit.
Method of Description	Winkler titration. Manganese is added to an alkaline sample (high pH) solution containing iodide to form a solid. The solution is acidified, resulting in a colored solution containing iodide molecules (I2). The solution is then titrated with thiosulfate. The volume of thiosulfate needed to reach the endpoint is used to determine the amount of dissolved oxygen in the sample.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 360.2).
Measurement Range	0.2 to 20 mg/L.
Accuracy	±0.1%.
Response Time	30 min. (time to perform analysis).
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Nitrate. Can be eliminated by using azide-containing reagents. - Reducing or oxidizing substances (e.g., organic matter). - Sulfides.
Staff Time Requirements	Low.
Level of Staff Knowledge	Moderate.
O&M Issues	None known.
Data Retrieval	- Visual identification of titration end point. - Calculation for DO using volume of titrant used.
Recommended Features	N/A.
Optional Features	N/A.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 87

Colorimetric

1. Description

Analytical Process

A sample bottle is filled completely with water so that no air bubbles are included. A reagent is added to the sample and mixed, resulting in a color change. The color is then compared to a color chart or measured using a photometer or spectrophotometer to determine the DO concentration.

Advantages

More accurate than Winkler titration method.

Can be performed in an onsite lab.

Disadvantages

Limited range of DO measurement.

Notes

Most significant reason for use: does not require maintenance of probe.

Most significant reason to avoid: requires chemical reagents and onsite lab.

Typical equipment includes reaction vials and a color chart/photometer/spectrophotometer.

Recommended system components: none.

Typical replacement items include lamp for photometer/spectrophotometer.

Consumables include reagents.

Analysis must be performed immediately upon sample collection or within 45 min. Do not allow the sample to become agitated.

This method does not require calibration.

Replace spectrophotometer or photometer bulb or light source as necessary.

Shelf life of reagents is approximately 1 to 2 years.

2. Selection Criteria

Method and Use Status

Parameter	Dissolved oxygen (DO).
Type	Test kit.
Method of Description	Colorimetric. Manganese is added to an alkaline sample solution (high pH) containing iodide to form a solid. The solution is acidified, resulting in a colored solution containing iodide molecules (I2). Intensity of color is compared to a color chart, or the wavelength is measured by a spectrophotometer.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 15 mg/L.
Accuracy	- Color comparator only identifies range in DO concentration ±0.01 mg/L.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Nitrate. Can be eliminated by using azide-containing reagents. - Reducing or oxidizing substances (e.g., organic matter). - Sulfides. - Copper, iron, chromium, manganese, and nickel (10 mg/L for high-concentration DO samples).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	None known.
Data Retrieval	Visual; local readout.
Recommended Features	N/A.
Optional Features	N/A.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 88

Thermocouple

1. Description

Analytical Process

The temperature probe is immersed in the sample stream. The probe contains two different metal strips joined at one end. The voltage produced between the two metal strips is proportional to the temperature.

Advantages

Quick response.

Disadvantages

Poor to fair long-term stability (duration the unit will stay calibrated).

Fair accuracy.

Sensor must be immersed to obtain temperature. Some probes identify the immersion level for accurate temperature reading.

Notes

Most significant reason for use: requirement for continuous temperature measurement.

Most significant reason to avoid: maintenance of in-stream sensor.

Typical equipment includes temperature sensor and monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Accuracy of sensor can be checked using a hot water or ice bath. When temperature readings are erratic or not accurate, the sensor is replaced.

Service life of a thermocouple sensor varies depending on exposure elements, but they typically have a long service life (i.e., over 10 years).

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Online monitor.
Method of Description	Thermocouple. The sensor is composed of two different metal strips joined at one end. When temperature changes, a voltage is produced between the two metals. The voltage is correlated to the temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Thermocouples are not included under the EPA method for temperature, but are approved for use in other environmental methods.
Measurement Range	–418°F to 2282°F (–250°C to 1250°C).
Accuracy	±1.9°F to 4.0°F (±1.0°C to 2.2°C).
Response Time	Several seconds.
Siting Constraints/Needs	- Structure needed to mount sensor. - Electricity.
Flow and Stream Constraints	- Sensor must be submerged in sample stream. - Internal sensor and wiring can become damaged if protective sheath is not intact and components come in contact with water.
Interferences	Electromagnetic (i.e., high-voltage wires, magnetic flow meters).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic sensor and battery replacement. - Periodic calibration.
Data Retrieval	Local readout.
Recommended Features	- Shielded sensors to reduce electromagnetic interference. - Waterproof enclosure.

Optional Features	- Monitor unit can typically connect to other probes to monitor additional parameters (e.g., DO, conductivity, pH). - Highly sensitive temperature sensors are available.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 89

Resistance-Temperature Detectors (RTD)/Thermistors

1. Description

Analytical Process

The temperature probe is immersed in the sample stream. Thermistors are composed of a sensor containing semiconductors connected to a monitoring unit. RTD thermometers are composed of a metal sensor that is typically wire-wound, coiled, or thin-film platinum connected to a monitoring unit. A current is passed through the probe, and the electrical resistance is proportional to the temperature.

Advantages

Quick response.

Accurate readings.

Disadvantages

Fragile sensor.

Thermistors have poor long-term stability (duration the unit will stay calibrated).

Sensor must be immersed to obtain temperature.

Notes

Most significant reason for use: requirement for continuous temperature measurement.

Most significant reason to avoid: maintenance of in-stream sensor.

Typical equipment includes temperature sensor and monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Typically, when temperature readings are not accurate, the sensor is replaced. Accuracy of sensor can be checked using a hot water or ice bath.

Factors such as excessive exposure to vibration or heat typically cause sensors to fail. Sensor probes or connection wires may need to be replaced approximately every couple of years, depending on use of equipment.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Online monitor.
Method of Description	Resistance-temperature detectors (RTD)/thermistors The temperature sensor is made of a material for which electrical resistance changes when temperature changes. Thermistors are typically composed of ceramic or polymer, while RTDs are typically composed of pure metal. The resistance is correlated to the temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	Federal approval (EPA Method 170.1).
Measurement Range	32°F to 212°F (0°C to 100°C).
Accuracy	±0.2°F to 0.4°F (±0.1°C to 0.2°C).
Response Time	Several seconds.
Siting Constraints/Needs	- Needs to be mounted carefully to avoid damaging the sensor. - Structure needed to mount sensor. - Electricity.
Flow and Stream Constraints	- Sensor must be submerged in sample stream. - Internal wiring can become damaged if protective sheath is not intact and components come in contact with water.
Interferences	Electromagnetic (i.e., high-voltage wires, magnetic flow meters).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic sensor and battery replacement. - Periodic calibration.
Data Retrieval	Local readout, USB connection, analog connection.

Recommended Features	- Shielded sensors to reduce electromagnetic interference. - Waterproof enclosure.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., DO, conductivity, pH).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low

FACT SHEET 90

Infrared Detector

1. Description

Analytical Process

The monitor unit detects infrared energy given off by an object. The peak of the infrared energy is related to the temperature of the object.

Advantages

Easy to use.

Disadvantages

Technology is not typical for storm water installations.

Fair accuracy.

Sensors are sensitive and must be protected from dirt, dust, flames, and so forth.

Notes

Most significant reason for use: inaccessible sample location.

Most significant reason to avoid: potential interferences and inaccuracy of surface reading.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Temperature sensors are typically purchased based on expected temperature range.

Detectors are calibrated based on measurement of targets with known temperature. Emissivity of the target must be also known. To calibrate for emissivity effects, a blackbody calibration instrument is required. It is recommended that infrared detectors be calibrated annually. Most manufacturers calibrate infrared monitors for a yearly fee.

Service life of an infrared sensor varies depending on use, but they typically have a service life exceeding 10 years. If a component fails, typically the entire unit is replaced.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Handheld monitor.
Method of Description	Infrared detectors. A noncontact temperature sensor that measures infrared energy emitted by a material. The energy detected is converted to an electrical signal that is displayed as temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	–76°F to 3632°F (–60°C to 2000°C).
Accuracy	±3.6°F (±2°C).
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Only surface temperature is monitored.
Interferences	- Electromagnetic (i.e., high-voltage wires, magnetic flow meters). - Surface reflectivity.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic sensor and battery replacement. - Periodic calibration. - Sensor cleaning.
Data Retrieval	Local readout, analog connection.
Recommended Features	None known.
Optional Features	Audible and visible alarms.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 91

Bimetal

1. Description

Analytical Process

The temperature probe is immersed in the sample stream. The probe is composed of two different metals joined at one end that expand/contract at different rates depending on temperature. Temperature corresponds to the mechanical displacement (i.e., thermal expansion) between the two metals. The readout is typically a dial.

Advantages

Familiar to most individuals.

Disadvantages

Slow response time.

Limited length of immersion probe.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: close contact with sample (i.e., sensor and dial are attached—no wire in between).

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Typically used in the laboratory (i.e., not in the field).

Bimetal thermometers consist of a metal stem, coil of two different metals, and a temperature indicator (as one unit).

Accuracy of thermometer can also be checked using a hot water or ice bath.

Bimetal thermometers are replaced as an entire system.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Handheld monitor.
Method of Description	Bimetal. A sensor composed of strips of two different metals joined at one end that expand/contract at different rates depending on temperature. The mechanical displacement (i.e., thermal expansion) between the two metals is correlated to the temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	–94°F to 1004°F (–70°C to 540°C).
Accuracy	±1.8°F (±1°C).
Response Time	Up to 5 min.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for sensor immersion.
Interferences	None known.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	Periodically calibrate.
Data Retrieval	Visual.
Recommended Features	Displays temperature within a specified range. Need to know temperature range of flow/stream.
Optional Features	None known.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 92

Glass Liquid Thermometer

1. Description

Analytical Process

The glass tube filled with mercury or other liquid is inserted into a sample or sample stream. The level of the liquid corresponds to temperature, which is read on an etched scale on the glass tube.

Advantages

Familiar to most individuals.

Disadvantages

Fragile and typically contains mercury, which requires special handling and disposal if thermometer is broken.

May be difficult to read.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: high potential for breaking.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Glass liquid thermometers consist of an etched glass cylinder containing either mercury or alcohol.

Glass liquid thermometers are usually calibrated using calibration baths. Accuracy of thermometer may be checked using a hot water or ice bath. Typically, when temperature readings are not accurate, the thermometer is replaced, or a correction factor is used when measuring temperature.

Glass liquid thermometers are replaced as an entire system.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Handheld monitor.
Method of Description	Glass liquid thermometer. A glass tube filled with mercury or other liquid that increases/decreases level when immersed in a sample. The level of the liquid corresponds to temperature, which is read on an etched scale on the glass tube.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 170.1).
Measurement Range	–328°F to 1112°F (–200°C to 600°C).
Accuracy	±0.05°F to 0.9°F (±0.03°C to 0.5°C).
Response Time	Several seconds.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for sensor immersion.
Interferences	None.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Breakage of glass tube. - Mercury disposal.
Data Retrieval	Visual.
Recommended Features	Purchase thermometers that do not contain mercury.
Optional Features	N/A.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 93

Thermocouple

1. Description

Analytical Process

The temperature probe is immersed in the sample stream. The probe contains two different metal strips joined at one end. The voltage produced between the two metal strips is proportional to the temperature.

Advantages

Familiar to most individuals.

Disadvantages

Poor to fair long-term stability (duration the unit will stay calibrated).

Fair accuracy.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: periodic recalibration required.

Typical equipment includes: monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Accuracy of sensor can also be checked using a hot water or ice bath. Typically, when temperature readings are not accurate, the sensor is replaced. Sensors can also be calibrated by the manufacturer or with a certified reference thermometer.

Service life of thermocouple sensor varies depending on exposure elements, but they typically have a long service life.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Handheld monitor.
Method of Description	Thermocouple. The sensor is composed of two different metal strips joined at one end. When temperature changes, a voltage is produced between the two metals. The voltage is correlated to the temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Thermocouples are not included under the EPA method for temperature, but are approved for use in other environmental methods.
Measurement Range	–418°F to 2282°F (–250°C to 1250°C).
Accuracy	±1.8°F to 4.0°F (±1.0°C to 2.2°C).
Response Time	Several seconds.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	- Sufficient depth for sensor immersion. - Internal sensor and wiring can become damaged if protective sheath is not intact and components come in contact with water.
Interferences	Electromagnetic (i.e., high-voltage wires, magnetic flow meters).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic sensor and battery replacement. - Periodic calibration.
Data Retrieval	Local readout.
Recommended Features	Shielded sensors to reduce electromagnetic interference.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., DO, conductivity, pH).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 94

Resistance-Temperature Detectors (RTD)/Thermistors

1. Description

Analytical Process

The temperature probe is immersed in the sample stream. Thermistors are composed of a sensor containing semiconductors connected to a monitoring unit. RTD thermometers are composed of a metal sensor that is typically wire-wound, coiled, or thin-film platinum connected to a monitoring unit. A current is passed through the probe, and the electrical resistance is proportional to the temperature.

Advantages

Familiar to most individuals.

Accurate readings.

Disadvantages

Fragile sensor.

Sensor must be immersed to obtain temperature.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: none.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

RTD thermometers are composed of a metal sensor that is typically wire-wound, coiled, or thin-film platinum connected to a monitoring unit. Thermistors are composed of a sensor containing semiconductors connected to a monitoring unit.

Accuracy of sensor can be checked using a hot water or ice bath. Typically, when temperature readings are not accurate, the sensor is replaced.

Factors such as excessive exposure to vibration or heat typically cause sensors to fail. Depending on use of equipment, sensor probes or connection wires may need to be replaced every couple of years.

2. Selection Criteria

Method and Use Status

Parameter	Temperature.
Type	Handheld monitor.
Method of Description	Resistance-temperature detectors (RTD)/thermistors. The temperature sensor is made of a material for which electrical resistance changes when temperature changes. Thermistors are typically composed of ceramic or polymer, while RTDs are typically composed of pure metal. The resistance is correlated to the temperature.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	Yes.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	Federal approval (EPA Method 170.1).
Measurement Range	–328°F to 752°F (–200°C to 400°C).
Accuracy	±0.2°F to 0.4°F (±0.1°C to 0.2°C).
Response Time	Several seconds.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	- Sufficient depth for sensor immersion. - Internal wiring can become damaged if protective sheath is not intact and components come in contact with water.
Interferences	Electromagnetic (i.e., high-voltage wires, magnetic flow meters).
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Periodic sensor and battery replacement. - Periodic calibration.
Data Retrieval	Local readout, USB connection, analog connection.
Recommended Features	Shielded sensors to reduce electromagnetic interference.
Optional Features	Monitor unit can typically connect to other probes to monitor additional parameters (e.g., DO, conductivity, pH).

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 95

Scattered Light Detection

1. Description

Analytical Process

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample flows continuously into a cell where a beam of infrared or visible light is projected through the sample. The amount of infrared or visible light that bounces off particles in the sample is measured by a photosensor adjacent to (for 180°) or perpendicular to (for 90°) the light emitter and correlated to a concentration of total suspended solids.

Advantages

Best for measuring lowest ranges (<10 mg/L TSS).

No consumables are required.

Automatic cleaning of lens reduces maintenance.

Disadvantages

Does not directly monitor solids concentration—is a correlation to turbidity.

Notes

Most significant reason for use: requirement for continuous TSS measurement.

Most significant reason to avoid: maintenance of online monitor and limited range.

Typical equipment includes monitor unit.

Recommended system components include cleaning system.

Typical replacement items: none.

Consumables: none.

Calibration curve needs to be developed at an independent lab using the gravimetric method.

Two styles available: immersion type (used in a tank or channel), and insertion type (used in a pipe).

Automatic cleaning systems using wipers tend to require more maintenance than those using air jets or water jets.

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Online monitor.
Method of Description	Scattered light detection. The amount of infrared or visible light that bounces off the solids in the sample is measured by a photosensor adjacent to or perpendicular to the light emitter. The light measured is correlated to the total suspended solids concentration.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 1,000 mg/L (up to 4,000 mg/L depending on manufacturer and model).
Accuracy	±5% (down to ±1% depending on manufacturer and model).
Response Time	Immediate.
Siting Constraints/Needs	Electricity (some models are battery powered).
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required. - Flow velocity < 9.8 ft/s.
Interferences	- Air bubbles. - Dyes or coloring.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Lens cleaning. - Calibration.
Data Retrieval	Local readout.
Recommended Features	- Automatic cleaning system (compressed air or water jet). - Air bubble compensation to reduce interference.
Optional Features	- Analog connection. - Ultrasonic cleaning.

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 96

Optical/Absorbance

1. Description

Analytical Process

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample flows continuously into a cell, where a beam of UV or visible light is projected through the sample. The absorbance of UV or visible light by solids in the sample is measured by a photosensor across from the light emitter and correlated to a concentration of total suspended solids.

Advantages

No consumables are required.

Automatic cleaning of lens reduces maintenance.

Disadvantages

Does not directly monitor solids concentration—is a correlation to turbidity.

Notes

Most significant reason for use: requirement for continuous TSS measurement.

Most significant reason to avoid: maintenance of in-stream sensor.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Available ranges of units (in mg/L TSS) include 10 to 2,000; 30 to 30,000; 100 to 10,000; 800 to 80,000

Two styles available: immersion type (used in a tank or channel) and insertion type (used in a pipe).

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Online monitor.
Method of Description	Optical/absorbance. The absorbance of UV or visible light by solids in the sample is measured by a photosensor across from the light emitter. The absorbance is correlated to the total suspended solids concentration.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	10 to 10,000 mg/L (see notes).
Accuracy	±5%.
Response Time	Immediate.
Siting Constraints/Needs	- Electricity (some models are battery powered). - Compressed air or potable water (if needed for cleaning equipment).
Flow and Stream Constraints	For gravity storm sewers, a sample pump/sample loop is typically required.
Interferences	- Air bubbles. - Dyes or coloring.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Check auto-cleaning equipment. - Calibration checks as needed. - Annual recalibration.
Data Retrieval	Local readout; analog connection.
Recommended Features	- LED compensation to reduce drift. - Automatic cleaning system (compressed air or water jet).
Optional Features	Serial port connection.

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 97

Laser Diffraction

1. Description

Analytical Process

This unit is installed inline with the sample stream or in an offline sample loop or flow cell. The sample flows continuously into a cell where a beam of laser light is projected through the sample. The amount and angle of laser light that bounces off solids in the sample are measured by a photosensor at a low angle across from the light emitter and correlated to a concentration of total suspended solids.

Advantages

Provides particle size analysis in addition to TSS.

No calibration is typically necessary.

No consumables are required.

Disadvantages

Biological growth that fouls the instrument lenses can be increased by the presence of deicer.

Does not directly monitor solids concentration—is a correlation to turbidity.

The lack of analog communication requires staff to visit instrument on-site to download data.

Notes

Most significant reason for use: requirement for continuous TSS measurement.

Most significant reason to avoid: maintenance of in-stream sensor.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

Instrument reads a volumetric measurement of sediment in the sample. A conversion factor to mg/L TSS is required.

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Online monitor.
Method of Description	Laser diffraction. The amount and angle of laser light that bounces off the solids in the sample are measured by a photosensor at a low angle across from the light emitter. The light detected and the angle are correlated to a total suspended solids concentration.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	Diversion, collection system monitoring, outfall discharge, treatment influent, treatment effluent.
Regulatory-Approved Method	None reported.
Measurement Range	10 to 3,000 mg/L.
Accuracy	Not available.
Response Time	5 min. minimum (programmable).
Siting Constraints/Needs	- Potable water. - Electricity. - Weatherproof shelter.
Flow and Stream Constraints	- For gravity storm sewers, a sample pump/ sample loop is typically required. - Sample pump flow rate is typically <1 gpm.
Interferences	None known.
Staff Time Requirements	Medium.
Level of Staff Knowledge	Low.
O&M Issues	- Biological growth on lenses can cause drift. - Tubing can get clogged with biological growth.
Data Retrieval	Local readout, serial port communication.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	Low.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 98

Optical/Absorbance

1. Description

Analytical Process

A sample is collected and placed into a sample vial. The sample vial is placed into a photosensor. The absorbance of UV and/or visible light by solids in the sample is measured by a photosensor across from the light emitter and correlated to a concentration of total suspended solids.

Advantages

Easy to use.

Disadvantages

Some models have a short useful life (approximately 2 years).

Does not directly monitor solids concentration—is a correlation to turbidity.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: maintenance of handheld probe.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

This monitor is a portable version similar to the online instruments. The calibration curve needs to be developed at an independent lab using the gravimetric method.

Some models include air bubble compensation to reduce interferences.

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Handheld monitor.
Method of Description	Optical/absorbance. The absorbance of UV and/or visible light by solids in the sample is measured by a photosensor across from the light emitter. The light absorbed is correlated to the total suspended solids concentration.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	1 to 400,000 mg/L.
Accuracy	±4% or 1 mg/L, whichever is greater.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	Sufficient depth for probe immersion.
Interferences	- Air bubbles. - Dyes or coloring.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Lens cleaning. - Calibration.
Data Retrieval	Local readout.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 99

Optical/Absorbance

1. Description

Analytical Process

A sample is collected and placed into a sample vial. The sample vial is placed into a photosensor. The absorbance of UV and/or visible light by solids in the sample is measured by a photosensor across from the light emitter and correlated to a concentration of total suspended solids.

Advantages

Benchtop photometer may be used for other analyses.

Disadvantages

Does not directly monitor solids concentration—is a correlation to turbidity.

Notes

Most significant reason for use: ease of use.

Most significant reason to avoid: maintenance of handheld probe.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

This monitor is a benchtop version similar to the online instruments. The calibration curve needs to be developed at an independent lab using the gravimetric method.

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Test kit.
Method of Description	Optical/absorbance. The absorbance of UV and/or visible light by solids in the sample is measured by a photosensor across from the light emitter. The light absorbed is correlated to the total suspended solids concentration.
Level of Technology Development	Well established.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Many manufacturers.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	0 to 750 mg/L.
Accuracy	Not available.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	- Air bubbles. - Dyes or coloring.
Staff Time Requirements	Low.
Level of Staff Knowledge	Low.
O&M Issues	- Calibration. - Replace batteries.
Data Retrieval	Local readout.
Recommended Features	Carrying case.
Optional Features	Serial port connection.

Typical Costs

Capital Cost	Very low.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.

FACT SHEET 100

Laser Diffraction

1. Description

Analytical Process

A sample is collected and placed into a sample vial. The sample vial is placed into a photosensor. The amount and angle of laser light that bounces off solids in the sample are measured by a photosensor at a low angle across from the light emitter and correlated to a concentration of total suspended solids.

Advantages

Provides particle size analysis in addition to TSS.

No calibration is typically necessary.

No consumables are required.

Portable design can be taken out for testing samples in the field.

Disadvantages

Biological growth that fouls the instrument lenses can be increased by the presence of deicer.

Does not directly monitor solids concentration—is a correlation to turbidity.

Notes

Most significant reason for use: no maintenance of handheld units.

Most significant reason to avoid: requires chemical reagents and on-site lab.

Typical equipment includes monitor unit.

Recommended system components: none.

Typical replacement items: none.

Consumables: none.

This monitor is a portable/benchtop version of the online instrument.

Instrument reads a volumetric measurement of sediment in the sample. A conversion factor to mg/L TSS is required.

2. Selection Criteria

Method and Use Status

Parameter	Total suspended solids (TSS).
Type	Test kit.
Method of Description	Laser diffraction. The amount and angle of laser light that bounces off the solids in the sample is measured by a photosensor at a low angle across from the light emitter. The light detected and the angle are correlated to a total suspended solids concentration.
Level of Technology Development	Emergent.
Demonstrated Technology for Airport Storm Water?	No.
General Availability of Technology	Single manufacturer.

Implementation Considerations

Typical Installation Locations	N/A.
Regulatory-Approved Method	None reported.
Measurement Range	10 to 3,000 mg/L.
Accuracy	Not available.
Response Time	Immediate.
Siting Constraints/Needs	N/A.
Flow and Stream Constraints	None known.
Interferences	None known.
Staff Time Requirements	Medium.
Level of Staff Knowledge	Low.
O&M Issues	- Biological growth on lenses can cause drift. - Replace batteries.
Data Retrieval	Local readout, serial port communication.
Recommended Features	None known.
Optional Features	None known.

Typical Costs

Capital Cost	Medium.
Typical Additional Capital Cost	N/A.
Annual Operations and Maintenance Cost	Low.