City of Baltimore
Department of Public Works

Modified Consent Decree
Investigation and Elimination Plan for Sanitary Discharges of Unknown Origin (SDUO)

Sanitary Sewer Overflow Consent Decree
Civil Action No. JFM-02-1524

February 2, 2018

CATHERINE E. PUGH
MAYOR

BALTIMORE CITY
DPW
DEPARTMENT OF PUBLIC WORKS
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Table of Contents

Appendix A: Sewer Discharges of Unknown Origin Quantification Protocol

List of Tables

Acronyms and Abbreviations

City	Mayor and City Council of Baltimore
CSR	Customer Service Request
DHCD	Baltimore City Department of Housing and Community Development
DPW	Baltimore City Department of Public Works
EPA	United States Environmental Protection Agency
MDE	Maryland Department of the Environment
mg/l	Milligrams per Liter
OAM	DPW Office of Asset Management
OCAL	DPW Office of Compliance and Laboratories
OEC	DPW Office of Engineering and Construction
OLRA	DPW Office of Legal and Regulatory Affairs
OCAL-WQMI-IU	DPW Office of Compliance and Laboratories, Water Quality Monitoring, Investigation Unit
OCAL-WQMI-RM	DPW Office of Compliance and Laboratories, Water Quality Monitoring, Routine Monitoring Unit
PST	Pollution Source Tracking
SSO	Sanitary Sewer Overflow
SSO Structure	A structure constructed to allow discharge from the separate sanitary sewer system at a point prior to the headworks of either the Patapsco or Back River wastewater treatment plants.
SDUO	Sanitary Discharge of Unknown Origin
TKN	Total Kjeldahl Nitrogen
UMD	DPW Utility Maintenance Division

Glossary

Collection System: Any collection and transmission system (including all pipes, force mains, sanitary sewer lines, combined sewer lines, if any, overflow structures, regulators, lift stations, pumping stations, manholes, and appurtenances thereto) owned by the City and designed to convey sewage to any treatment plant(s) or in wet weather to an overflow structure.

Consent Decree: The Modified Consent Decree and any subsequent modifications thereto in settlement of civil action number JFM-02-1524.

Illicit Discharge: Any discharge to the storm sewer system that is prohibited by federal, State, or local law.

Sanitary Sewer Overflow (SSO): Any spill, release, or discharge of wastewater from any portion of the Collection System into the environment.

Sanitary Sewer Overflow Structure/SSO Structure: Any structure constructed to allow discharge from the separate sanitary sewer system at a point prior to the headworks of either the Patapsco or Back River wastewater treatment plants.

Sanitary Discharge of Unknown Origin (SDUO): Any discharge of sewage through the City's storm sewer system, where the source of the sewage is unknown.

Storm Sewer System: The City's municipal separate storm sewer system as defined in 40 C.F.R. § 122.26(b)(4) that is subject to Permit Number 11-DP-3315 MD0068292.

1.0 INTRODUCTION

The Mayor and City Council of Baltimore (the City) acting by and through its Department of Public Works (DPW) is responsible for investigating and eliminating illicit discharges to the storm sewer system. If an illicit discharge appears to be related to sewage, based on visual and chemical indicators, but the source(s) cannot be identified, then the discharge is classified as a sanitary discharge of unknown origin (SDUO) for further investigation. DPW will track and report efforts to investigate and eliminate SDUOs as part of the calendar quarterly progress report under Paragraph 21 of the Consent Decree. Notifications pertaining to SDUOs will be performed in accordance with the City’s approved Emergency Response Plan.

1.1 Purpose

The purpose of this plan for the investigation and elimination of SDUOs (SDUO Plan) is to define roles and responsibilities for investigating and eliminating confirmed SDUOs in the storm sewer system pursuant to Paragraph 15 of the Consent Decree. The SDUO Plan includes the following: (1) timelines for the investigation of SDUOs and correction of Collection System deficiencies, if any, once the source(s) are identified; (2) identification of the personnel and offices responsible for SDUO investigations, and clarification of responsibility to ensure effective implementation of the SDUO Plan; and (3) tracking mechanisms to investigate SDUOs and verify SDUO abatement. The SDUO Plan also includes the Sewer Discharges of Unknown Origin Quantification Protocol dated November 12, 2010, and submitted by the City to the U.S. Environmental Protection Agency (EPA) on November 18, 2010 (SDUO Protocol). The SDUO Protocol is attached as Appendix A. DPW will use the SDUO Protocol to calculate the volume and rate of sewage discharge for confirmed SDUOs.

1.2 Responsibilities

DPW is responsible for investigating sewage discharges to the storm sewer system and tracking the elimination of these discharges. These activities are conducted through the following DPW offices: Office of Compliance and Laboratories (OCAL); Office of Asset Management (OAM); Office of Engineering and Construction (OEC); Utility Maintenance Division (UMD); and the Office of Legal and Regulatory Affairs (OLRA). The aforementioned DPW offices perform the following roles:

- OCAL initiates investigations of SDUOs, confirms the source(s) of sewage discharges, issues notices of correction, and verifies elimination of confirmed sewage discharges.
    - The DPW Office of Compliance and Laboratories, Water Quality Monitoring, Routine Monitoring Unit (OCAL-WQMI-RM) – collects field monitoring samples on a routine basis as part of a trend analysis for water quality and to identify potential illicit discharges to surface waters.
    - The DPW Office of Compliance and Laboratories, Water Quality Monitoring, Investigation Unit (OCAL-WQMI-IU) – investigates potential illicit discharges,

designates SDUOs, collaborates with property owners and other City agencies to abate SDUOs, and manages the SDUO database and all records related to SDUOs.

- OCAL is responsible for issuing notices of violation and pursues enforcement actions against confirmed sewage discharges from private property in coordination with OLRA.
- OAM, OEC, and UMD provide assistance to OCAL for some investigation activities and corrective actions, as required, on public assets.

If a discharge is confirmed to originate from private property, the owner of the property is responsible for eliminating the discharge. DPW is authorized to conduct enforcement actions pursuant to Article 25 of the Baltimore City Code to eliminate illicit discharges.

The Baltimore City Department of Housing and Community Development (DHCD) is similarly authorized to enforce the City's Building Code. If DPW is unable to obtain consent to investigate private property for a suspected illicit discharge, DHCD's enforcement authority may enable DPW to obtain access and complete the investigation. DHCD may also issue Building Code violations, in coordination with DPW's enforcement actions, to mandate abatement of illicit discharges originating from private property.

2.0 INVESTIGATION AND ABATEMENT

2.1 Phase I PST Investigation

OCAL-WQMI-RM will initiate a Phase I pollution source tracking (PST) investigation when routine field monitoring results indicate a potential sewage discharge as provided below, or when the City's 311 non-emergency system receives a customer service request (CSR) for polluted waterways. Phase I PST investigations begin at the storm sewer system outfall and continue upstream through the storm sewer system until the origin(s) of the discharge, if any, are confirmed. OCAL-WQMI-RM will use the following field screening methods during the Phase I PST investigation for sewage discharge(s):

- Ammonia-nitrogen measurements from the storm sewer system are the main field screening criteria. For sewage discharges, the initial field indicator is typically an ammonia-nitrogen measurement greater than 0.3 milligrams per liter (mg/l). This indicator may vary based on average historic sampling data and field conditions as determined using reasonable engineering judgment. If interference is reasonably suspected, optical brighteners,[1] or bacteria measurements may be used as surrogate indicators of sewage discharges.
- Area reconnaissance at the ground surface level to identify potential sources of high ammonia readings, such as surface discharge from public or private assets, sump pumps, dog parks, or similar areas with visible sanitary issues.
- Observations of the base flow within the storm sewer system related to changes in the flow rate, color, odor, and the presence of organic growth. Observations may be performed by either confined space entry or use of a camera device.
- Dye tests performed within the Collection System.
- Evaluation of data from previous PST investigations within the drainage area of the outfall.
- Other appropriate methods for detecting and tracking potential sewage discharges based on reasonable engineering judgment.

If OCAL-WQMI-RM determines that the discharge is likely to be sewage, the discharge is ongoing, and the source(s) cannot be identified during the Phase I PST investigation, then OCAL-WQMI-RM will transfer the investigation to OCAL-WQMI-IU and designate the discharge as an SDUO. If the source of the discharge is confirmed to originate from outside City limits, OCAL-WQMI-RM will notify the IDDE Program Coordinator of the Watershed Management and Monitoring Section of the Baltimore County Department of Environmental Protection and Sustainability within one (1) working day to take appropriate action. OCAL-WQMI-RM will then

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[1] Optical brighteners are often used in laundry detergents, cosmetics, and cleaning products. The presence of optical brighteners may indicate an illicit discharge to the storm sewer system.

close the Phase I PST investigation, noting that the investigation has been delegated to Baltimore County.

Records of field measurements, lab results, area reconnaissance notes, and dye test results will be stored within the PST application, a tablet-based data management system, or a successor data management system designated by DPW. A Phase I PST investigation should be completed within 10 working days from initiation of the investigation, unless otherwise noted within the PST investigation application.

2.2 Identification and Documentation Management

OCAL-WQMI-IU will designate the SDUO with a unique identifier and record the information in a database. The unique identifier will follow the format of YY-WS-XX as follows:

- YY is the last two digits of the year when the SDUO was identified.
- WS is the two-digit watershed of the discharge location: GF = Gwynn's Falls, JF = Jones Falls, BR = Back River, LP = Lower Patapsco, and DH = Direct Harbor.
- XX is the sequential, two-digit number assigned within the watershed for that year.

In addition, OCAL-WQMI-IU will maintain the following information in the database for each SDUO:

- Location description
- Source Type: city right-of-way, private property or unknown; direct or indirect discharge
- Repair Type: single or multiple
- Status
- Start date, end date, and duration
- Ammonia concentration based on field test (mg/l)
- Estimated flow (gallons per minute)
- Flow consistency
- Calculated total volume based on the SDUO protocol to estimate the discharge rate and dilution factor
- Any relevant notes on communications and actions towards abatement, including issuance of work orders or enforcement actions

Ammonia concentrations, estimated flow, and flow consistency may change pending the number and type of repairs to abate the SDUO. After each repair action, these parameters will be re-measured and integrated into the SDUO database. The total volume of discharge will be cumulative until the SDUO abatement is confirmed.

2.3 Phase II PST Investigation

OCAL-WQMI-IU will conduct the Phase II PST investigation, with assistance from other DPW personnel as-needed. A Phase II PST investigation may include the following investigation techniques to identify the discharge source(s) and identify potential abatement actions:

- Reviewing public records specific to the property or properties at-issue
- Dye testing from private properties, private laterals, Collection System laterals, and/or Collection System mains
- Smoke testing
- Pipe cleaning and CCTV of the Collection System and/or the storm sewer system
- Flow rate monitoring
- Exploratory excavations
- Hydraulic modeling
- Other methods or techniques as determined by DPW using reasonable engineering judgment

Phase II PST investigations should typically conclude within 4 to 6 weeks, pending authorization to enter private properties, if needed. This timeframe does not include the completion of abatement actions and does not consider unforeseen circumstances or unusual field conditions. As multiple sources may contribute to a single SDUO, multiple Phase II PST investigations may be required based on reasonable engineering judgment and field conditions, resulting in additional time, which will be determined on a case-by-case basis.

2.4 Abatement Based on Source

Abatement duration and approach can vary significantly based on the source(s) of the discharge. Frequently, the source(s) of the discharge may be variable or unknown. If so, the exercise becomes arduous and increases the difficulty of predicting time frames.

2.4.1 Failing Public Infrastructure

If OCAL-WQMI-IU confirms the source of the discharge as a Collection System asset, then the discharge will be reported as an SSO pursuant to sub-paragraph 17.e of the Consent Decree. The discharge rate and volume of the SSO will be calculated from the time that the SSO is confirmed. If the source of the discharge is attributable to failing public infrastructure, the SSO will be abated pursuant to the City’s approved Emergency Response Plan.

2.4.2 Cross-Connection from the Collection System

A cross-connection is a direct (piped) connection between the Collection System and the storm sewer system that discharges sewage during dry weather. If OCAL identifies the source of the discharge as a cross-connection between the Collection System and the storm sewer system, then OCAL-WQMI-IU will report the discharge as an SSO pursuant to sub-paragraph 17.e of the Consent Decree. The discharge rate and volume of the SSO will be calculated from the time that the SSO is confirmed. OAM will submit a schedule within 60 days to eliminate the cross-connection in accordance with sub-paragraph 15.c. of the Consent Decree.

A technical scope of work will be developed by OAM to disconnect the cross-connection appropriately. If the discharge rate changes before the disconnection is completed, OCAL-WQMI-IU will measure the sewage discharge flow rate and dilution factor, and adjust the quantity of discharge calculation in the SDUO database.

2.4.3 SSO Structures

If OCAL identifies the source of the discharge as an SSO Structure, then OCAL-WQMI-IU will verify whether the SSO Structure has been identified in Appendix A of the Consent Decree or reported to EPA and the Maryland Department of the Environment (MDE) as provided in sub-paragraph 8.b of the Consent Decree. If the SSO Structure has not been reported, OEC will develop a plan and schedule to eliminate the SSO Structure and submit these plans to EPA and MDE pursuant to sub-paragraph 8.b(iii) of the Consent Decree. All overflows from the SSO Structure shall be reported under Paragraph 17 of the Consent Decree.

2.4.4 Private Property Discharges

If OCAL confirms the source of the discharge as one or more private properties and the discharge is not attributable to improper construction by the City, OCAL-WQMI-IU will perform the actions listed below in Table 2-1 in coordination with OLRA, based on the estimated rate of discharge:

Table 2-1. Schedule for Addressing Discharges from Private Property

Document	Content	Schedule[2] based on Discharge	
		< 1 gpm	> 1 gpm
Door Hanger	Request to contact - based on field tests	Same day	Same day
Letter of Concern	SDUO found - Request access for testing	7 days	7 days
Notice of Correction	Technical report of findings - Offer of available support services Request for action plan Notification of potential penalties	30 days	14 days
Notice of Violation	Administrative order with penalty fine Process for appeal	30 days	14 days

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[2] Timeframes are measured in calendar days from the date of the most recent notification to the property owner or their authorized representative.

OCAL-WQMI-IU may also provide the property owner with technical guidance to facilitate abatement as appropriate under the circumstances. OCAL-WQMI-IU will notify OLRA if the property owner's response is insufficient. If so, OCAL may prepare an administrative order or penalties provided under Article 25 of the Baltimore City Code, or other legal authority as applicable. OCAL-WQMI-IU may also engage with DHCD to enforce potential building code violations. Records of investigations and enforcement will be included in the SDUO database.

2.4.5 Variable and Unknown

If OCAL-WQMI-IU is unable to identify a specific source using the methods in the Phase I and Phase II PST investigations, then OCAL-WQMI-IU will evaluate the following activities and direct UMD or OEC to take the following abatement actions as appropriate:

- Storm pipe cleaning to remove residual sediment influencing ammonia readings;
- Point repair or pipe lining of the storm sewer system to prevent sewage discharges into the storm sewer system; or
- Other measures as determined by DPW using reasonable engineering judgment.

2.5 Abatement Confirmation

2.5.1 Ammonia-Nitrogen Measurement

Once an abatement action has been completed, OCAL-WQMI-IU will measure the ammonia-nitrogen at the discharge location or the closest, accessible downstream point nearest to the location of the discharge to confirm that the SDUO has been eliminated. OCAL-WQMI-IU may also perform dye tests or similar measures to confirm abatement in accordance with reasonable engineering judgment.

If the downstream sample results show ammonia-nitrogen levels less than 0.3 mg/L[3], then OCAL-WQMI-IU will close the investigation and update the SDUO database to include any reports and evidence of work completed. Depending on the degree of uncertainty of the source, weather, and field conditions, confirmation of abatement and elimination of the sewage discharge may require up to three consecutive sampling events as determined by DPW using reasonable engineering judgment.

If the downstream sample results show ammonia-nitrogen levels greater than 0.3 mg/L, OCAL-WQMI-IU will perform a subsequent Phase II PST investigation, and update the SDUO database.

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[3] This indicator may vary based on average historic sampling data and field conditions as determined using reasonable engineering judgment.

3.0 CALENDAR QUARTERLY PROGRESS REPORTS

DPW will report SDUOs as provided in the approved Emergency Response Plan and Paragraph 21 of the Consent Decree. The calendar quarterly progress report will be submitted within 30 days after the end of each calendar quarter until the termination of the Consent Decree.

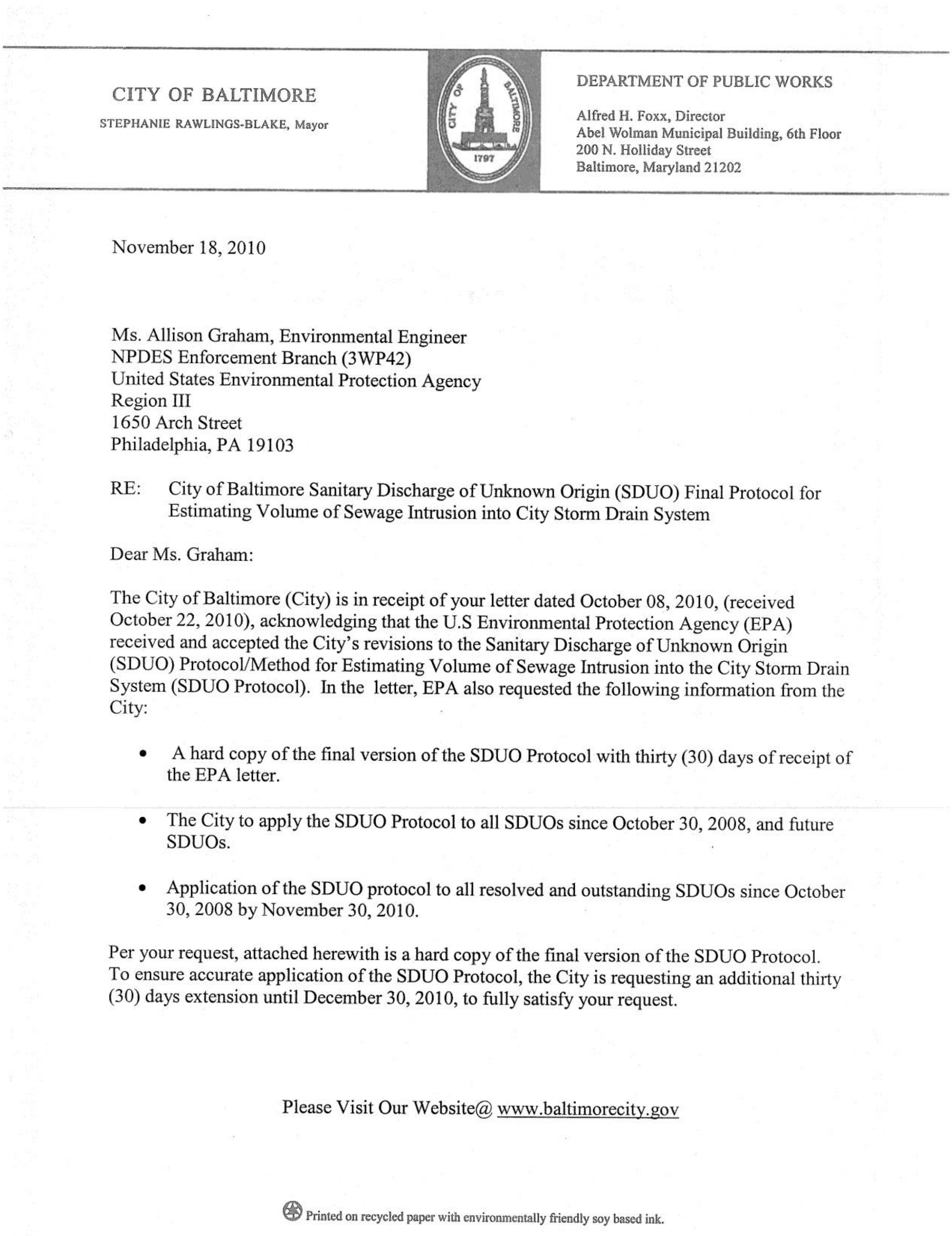
The calendar quarterly progress report will include a table that summarizes the following information for each SDUO that occurred and was identified in the reporting quarter:

- Date of occurrence
- Location, including zip code
- Water body affected
- Measures taken to investigate the source(s) of the SDUO
- Future work planned to identify and/or address the source(s) of the SDUO
- Date of resolution (if resolved)
- Duration
- Estimated volume of discharge in gallons

If a source of the SDUO has been confirmed to originate from the Collection System during the reporting quarter, the table will also indicate the date of the written report submitted pursuant to sub-paragraph 17.e.

If applicable, the calendar quarterly progress report will also include a table of previously reported SDUOs if one or more sources of the discharge were verified as an SSO during the reporting quarter. The table will include volume per SSO as calculated pursuant to the SDUO Protocol and sub-paragraph 17.a(ii).

Appendix A:
Sewer Discharges of Unknown Origin Quantification Protocol



CITY OF BALTIMORE
STEPHANIE RAWLINGS-BLAKE, Mayor

1797

DEPARTMENT OF PUBLIC WORKS

Alfred H. Foxx, Director
Abel Wolman Municipal Building, 6th Floor
200 N. Holliday Street
Baltimore, Maryland 21202

November 18, 2010

Ms. Allison Graham, Environmental Engineer
NPDES Enforcement Branch (3WP42)
United States Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103

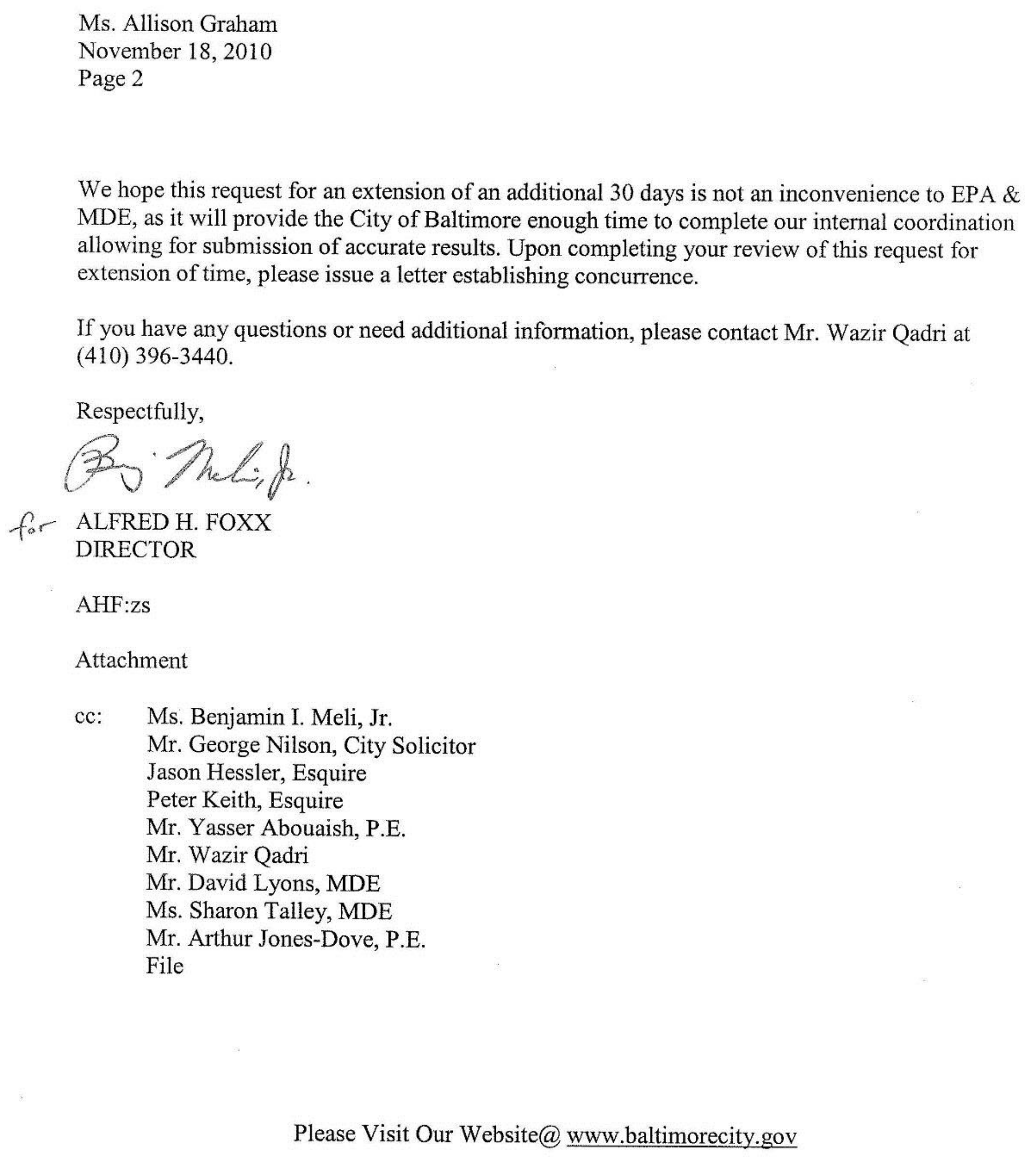
RE: City of Baltimore Sanitary Discharge of Unknown Origin (SDUO) Final Protocol for Estimating Volume of Sewage Intrusion into City Storm Drain System

Dear Ms. Graham:

The City of Baltimore (City) is in receipt of your letter dated October 08, 2010, (received October 22, 2010), acknowledging that the U.S Environmental Protection Agency (EPA) received and accepted the City's revisions to the Sanitary Discharge of Unknown Origin (SDUO) Protocol/Method for Estimating Volume of Sewage Intrusion into the City Storm Drain System (SDUO Protocol). In the letter, EPA also requested the following information from the City:

- A hard copy of the final version of the SDUO Protocol with thirty (30) days of receipt of the EPA letter.
- The City to apply the SDUO Protocol to all SDUOs since October 30, 2008, and future SDUOs.
- Application of the SDUO protocol to all resolved and outstanding SDUOs since October 30, 2008 by November 30, 2010.

Per your request, attached herewith is a hard copy of the final version of the SDUO Protocol. To ensure accurate application of the SDUO Protocol, the City is requesting an additional thirty (30) days extension until December 30, 2010, to fully satisfy your request.



Ms. Allison Graham
November 18, 2010
Page 2

We hope this request for an extension of an additional 30 days is not an inconvenience to EPA & MDE, as it will provide the City of Baltimore enough time to complete our internal coordination allowing for submission of accurate results. Upon completing your review of this request for extension of time, please issue a letter establishing concurrence.

If you have any questions or need additional information, please contact Mr. Wazir Qadri at (410) 396-3440.

Respectfully,

Benj. Meli, Jr.

for ALFRED H. FOXX
DIRECTOR

AHF:zs

Attachment

cc: Ms. Benjamin I. Meli, Jr.
Mr. George Nilson, City Solicitor
Jason Hessler, Esquire
Peter Keith, Esquire
Mr. Yasser Abouaish, P.E.
Mr. Wazir Qadri
Mr. David Lyons, MDE
Ms. Sharon Talley, MDE
Mr. Arthur Jones-Dove, P.E.
File

BUREAU OF WATER & WASTEWATER

Sewer Discharges or Unknown Origin Quantification Protocol

November 12, 2010

Standard Investigation, Sampling & Analytical Procedures and Volume Estimation Techniques Used for Identification and Quantification of Possible Releases of Sewage to Storm Drains or Surface Waters of Baltimore City

I. Purpose

The following describes standard procedures for collecting and analyzing aqueous samples. The purpose of the sampling described herein is to allow for a determination of whether flow from the City of Baltimore's sanitary sewer collection system is entering the storm sewer system or surface waters of the City. Analytical results from this sampling, along with flow information collected in the field, are then used to quantify the total volume discharged from a given source as required by the City's SSO Consent Decree.

II. Field Screening/Sampling

City personnel regularly collect and analyze samples in the field as part of the City's MS4 Stormwater Permit. Field personnel use a Hach Meter to perform a colorimetric test in the field. Field personnel utilize Method 10023, which measures NH3-N in the range of 0 to 2.50 mg/l. If the initial field measurement indicates a concentration exceeding Method 10023's range, field personnel employ Method 10031, which has a range of 0 to 50 mg/l. (Appendix A includes detailed procedures for collection and analysis using the Hach meter).

A value of over 0.3mg/l is considered indicative of sanitary contamination and initiates a focused investigation to locate the source.

III. Field Investigation

When initial sampling performed by the City indicates an elevated level of ammonia (a value of 03.mg/l or higher), City personnel attempt to locate the specific source or sources responsible for the elevated readings. Most often, this effort involves the methodical testing of ammonia levels upstream of the initial sample location. At some point in the effort, City staff will measure a distinct decrease in ammonia concentration. This tends to indicate that the source is immediately downstream.

Once the apparent source is bracketed between an upstream and a downstream manhole, City forces can then use various investigative methods to determine the specific source.

Most often, this effort begins with a visual inspection via manned entry into the pipe (if the pipe is large enough) or the use of CCTV (for smaller diameter pipes). Often times, the visual inspection will include the use of dye to assist the inspectors in locating the source. Depending on the physical layout of utilities in the area, dye may be introduced into local sanitary lines and/or from private properties.

When performing a "flush test" (i.e., introducing dye into the system via a toilet or other fixture), field personnel should be stationed at both the downstream storm manhole and the downstream sanitary sewer manhole. Field technicians should document the time the dye was first introduced into the system and the time that dye was first noted at a given sanitary or storm manhole.

If there is more than one sanitary line in the area of interest, field personnel may use different colored dyes for different sanitary sewers lines. Alternately, a single dye may be used. In this case, however, sufficient time needs to be allowed between tests in order to ensure that all of the dye has been fully flushed from the system before restarting the test at a new section.

If initial field investigative efforts are unsuccessful in identifying the specific source, additional fieldwork will be required. Such efforts include additional field screening/sampling, additional CCTV/dye testing/manned entry, construction of new access point (especially in the case where older, failed utilities are present), smoke testing, and sewer cleaning.

In all cases, field investigative efforts, including CCTV, dye testing and smoke testing shall be performed in accordance with EPA/625/6-91/030, EPA Sewer System Infrastructure Analysis and Rehabilitation, October 1991. This handbook is incorporated by reference to this document. As emphasized in the handbook, all fieldwork should be performed in accordance with NIOSH and OSHA regulations. This includes, but is not limited to: conforming to all confined space entry and maintenance of traffic requirements. In addition, all relevant local, state and federal provisions, guidelines, SOPs, directives, etc, shall be followed

IV. Sample Collection and Laboratory Analysis

Once the specific source of contamination is identified, City personnel collect samples for off-site analysis of total Kjeldahl Nitrogen (Standard Method 4500NH3-C) and Nitrate-Nitrite Nitrogen (Standard Method 4500NO3-H).

The City retains the services of a certified laboratory to perform the required analyses. The laboratory provides all required bottleware with premeasured preservative, a cooler for transportation back to the lab, and chain of custody forms.

City personnel use a clean container to collect a sufficient quantity of the sample and then transfer the sample directly into the clean laboratory bottleware. Prior to any additional sample collection, the collection container is cleaned out with uncontaminated water.

The chain of custody is then filled out. Each sample is given a unique ID number and information regarding the date/time, station location, preservative and analysis required is provided.

City personnel deliver the samples directly to the laboratory within five work days (significantly less than the 28-day holding time, giving the laboratory plenty of time to perform the analysis).

Laboratory results are returned to the City's Water Quality Management Office, which is responsible for distribution of the results to all interested parties.

V. Estimation of the Volume of the Discharge

Should the initial field screening measurements (as described above) indicate the presence of sanitary contamination, City forces will perform additional activities as required to identify the location where sanitary flow is entering the storm sewer system or surface waters. In some cases, the source will be immediately apparent. In other cases, the investigation will require extensive investigation including a focused field screening effort, the use of CCTV, dye testing, manned inspection and other techniques.

Once the source is identified, the concentration and rate of discharge of the source will be quantified using the procedures described herein.

1. Gross Volume Calculation

City personnel will use a three-tiered approach to quantify flow, depending on the type of flow encountered.

- The preferred method for quantifying the rate of flow is actual capture and measurement of the flow using a container and a stopwatch. This would be most appropriate for low to moderate flows that lend themselves to capture in a container (e.g., a pipe discharging into a larger pipe or a pipe discharging to a body of water). City forces already do this on sites that lend themselves to this approach.

- The next approach is for sites that don't lend themselves to the capture/measurement method. In this case, City personnel will use Chezy-Manning Equation, <u>if</u> the depth of flow, pipe/culvert geometry, pipe/culvert material, and the slope of the pipe can all be confirmed/approximated in the field or through review of City drawings.

    - The Chezy-Manning Equation is as follows:

      $$Q = A * 1.49/n * r_h^{2/3} * S^{1/2}$$

Where: Q = Rate of Flow (ft^3/s)
A = Area (ft^2)
r_h = Hydraulic Radius (ft) *(requires depth of flow)*
S = Slope (ft/ft) *(potentially difficult to determine for many of the City's sites)*
n = Manning's Roughness Coefficient

- For all other scenarios, sound engineering judgment/visual approximation will be used. Examples of this situation might include discharge/weeping from a manhole wall or bench that does not lend itself to collection of water in a volumetric container.

In the case of SDUOs that have already been abated, flow will be derived from file information or from conversations with personnel who observed the condition first-hand.

In the case of undiluted sewage entering a storm sewer, the volume would simply be calculated by multiplying flow by time (**$V_T=Q \cdot t$**), where
V_T = total Volume of discharge in gallons
Q = flow in gallons per minute
t = time in minutes

For Example if we assume a continuous flow of 0.5 gallons per minute and a t of 200 days, then t = 200 days · 24hrs/day · 60 min/hr = 288,000 minutes. The calculation is as follows below:

Total Vol. of Discharge (V_T) = 0.5 gallons/min · 288,000 min
= 144,000 gallons

Note: t is the number of days, from time of discovery of the SDUO by SWMD, Citizens or the City's Maintenance Division until the date of the abatement of the SDUO.

2. Dilution

The matter of flow calculation is more difficult where it is believed that the estimated flow includes groundwater and/or stormwater flow. In these instances, it will be necessary to estimate the portion of the flow attributed to sewage versus the portion attributable to non-sewage flow.

Historically, the City has utilized ammonia as their indicator parameter to identify potential sewage discharges into the storm sewers. As such, for all sites investigated to date, including those that have been permanently resolved, field-testing results for ammonia are the only analytic measurements available to assist in determining the extent of dilution in the gross flow.

It should be noted that ammonia was selected solely to act as an indicator that sewage was present in the flow. It was not intended to be used for purposes of accurately measuring dilution. Because of it's seasonal variability and because ammonia concentrations increase as sewage ages (i.e., concentration of ammonia tend to increase as it gets closer to the WWTPs), ammonia is not a "perfect" indicator (for purposes of this effort, a "perfect" indicator would be a compound with a known and constant concentration in sewage, unaffected by season or sewage age, that can be precisely measured and that is not subject to analytical interferences).

a. Dilution Calculation for Remediated Sites

As stated above, ammonia provides the only analytical data that can be used to calculate dilution for those sites that have already been remediated. For those sites, the equation below will be used to calculate the dilution factor. The general approach to the equation below is that a sample that is dilute will have a measured ammonia level of less than that of raw sewage. The equation below creates a ratio between the analytic value and the flow weighted average of ammonia entering the City's WWTPs.

$$d = (a - 0.3)/(17 - 0.3) = (a - 0.3)/16.7, \text{ where}$$

d = dilution factor, to account for presence of ground water, overland runoff, etc.

a = measured value of ammonia (mg/l)

17 mg/l is the flow-weighted average of ammonia entering the City WWTPs

0.3 mg/l is the action limit the City employs for identifying potential sanitary discharges to the storm system

This unitless d factor would be multiplied by gross flow. Continuing with the example above, we will assume an estimated continuous flow of 0.5 gallons per minute and a t of 200 days, further, we will assume that the measured value of ammonia was 5.0 mg/l. Accordingly, the volume of actual sewage would be calculated as shown below:

$$\text{Vol. of Sanitary Discharge } (V_C) = V_T \cdot d = 144{,}000 \text{ gallons x } (5 - 0.3)/16.7 \approx 40{,}000 \text{ gallons}$$

Note: In this example, we have assumed a continuously flowing SDUO.

b. Dilution Calculation for Active Sites

An alternate indicator parameter for calculating "d" is Total Kjeldahl Nitrogen (TKN). TKN, which is the total of organic nitrogen, NH_3 and NH_4, is less variable than ammonia because organic nitrogen compounds tend to decompose less compared to ammonia as they age in the collection system. Thus, while ammonia concentration would be expected to increase as the flow ages and gets closer to the treatment plant, TKN would generally be expected to stay constant. Therefore, TKN is a better indicator compound for purposes of calculating dilution and will be used by the City on all active and future SDUO investigations. The calculation for "*d*" using TKN is as follows:

$d = (a - 0.5)/ (27- 0.5) = (a - 0.5)/26.5$, where

d = dilution factor, to account for presence of ground water, overland runoff, etc.

a = measured concentration of TKN (mg/l).

27 mg/l is the flow-weighted average of TKN entering the City WWTPs.

0.5 mg/l value is derived from the 0.3 mg/l action level the City uses for ammonia multiplied by the average ratio between TKN and ammonia (~1.6 based on a review of the average flow weighted concentration of TKN vs. ammonia at the Back River and Patapsco WWTPs).

3. Accounting for Intermittent Flow

The City of Baltimore will maintain sufficient documentation to establish the volume of discharge, whether intermittent or a steady continuous flow. To the extent practical, the City will submit all calculations and volume determinations to EPA and MDE after 5 days of quantification

For each site at which the flow is not steady, the Bureau will have to establish a reasonable "*c*" factor, of less than one, to account for absence of steady flow. This *c* factor will have to be a reasonable estimate, on a site-by-site basis based on observation of the flow. This is the hardest factor to determine, therefore the estimation of the "c" factor would be based on engineering judgment and it is expected that most of these sites will need to be visited multiple times in order to generate enough information to formulate a site-specific "*c*" factor.

As such, where a gross volume V_T might have been calculated on the assumption of full strength sewage and steady continuous Q (flow value), the refined computation of a final non-continuous, dilute volume of discharge (V_{NC}) would be:

Volume of Sanitary Discharge (V_{NC}) $= V_T \cdot d \cdot c$
$= V_C \cdot c$

Continuing with the previous example above and adding an assumption that the flow is assumed to be active 10 percent of the time, the resulting calculation is as follows:

Volume of Sanitary Discharge (V_{NC}) **$= V_C \cdot c =$ 40,000 gallons x 0.1**
$\approx$ 4,000 gallons

Note: Each SDUO with intermittent flow would have to be evaluated based on the site-specific circumstances.

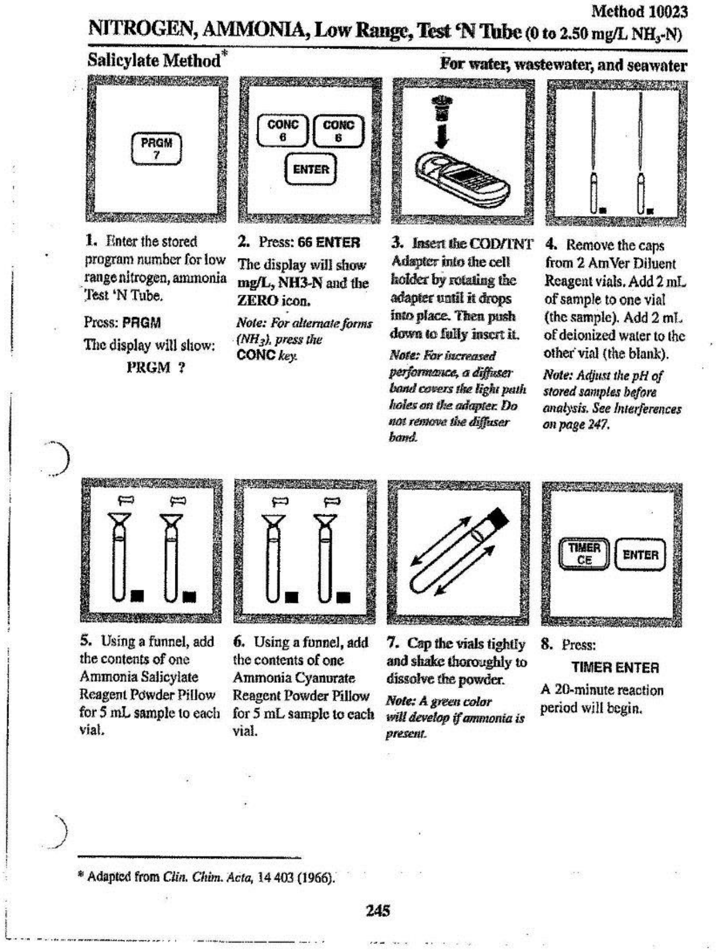
As previously indicated, the characteristics of the SDUO sites may vary greatly. Regardless of this variability, the City has attempted to provide a systematic approach to quantify these sites. Each site will be evaluated on a case-by-case basis and the necessary engineering judgment applied in the field to address sites that do not fall within the confines as stated above.

APPENDIX A

Hach Method 10023 – Low Range, Test 'N Tube
(0 to 2.50 mg/l NH_3 – N)

&

Hach Method 10031 – High Range, Test 'N Tube
(0 to 50 mg/l NH_3 – N)



Method 10023

NITROGEN, AMMONIA, Low Range, Test 'N Tube (0 to 2.50 mg/L NH_3-N)

Salicylate Method* **For water, wastewater, and seawater**

1. Enter the stored program number for low range nitrogen, ammonia Test 'N Tube.

Press: **PRGM**

The display will show:

PRGM ?

2. Press: **66 ENTER**

The display will show **mg/L, NH3-N** and the **ZERO** icon.

Note: For alternate forms (NH_3), press the **CONC** *key.*

3. Insert the COD/TNT Adapter into the cell holder by rotating the adapter until it drops into place. Then push down to fully insert it.

Note: For increased performance, a diffuser band covers the light path holes on the adapter. Do not remove the diffuser band.

4. Remove the caps from 2 AmVer Diluent Reagent vials. Add 2 mL of sample to one vial (the sample). Add 2 mL of deionized water to the other vial (the blank).

***Note:** Adjust the pH of stored samples before analysis. See Interferences on page 247.*

5. Using a funnel, add the contents of one Ammonia Salicylate Reagent Powder Pillow for 5 mL sample to each vial.

6. Using a funnel, add the contents of one Ammonia Cyanurate Reagent Powder Pillow for 5 mL sample to each vial.

7. Cap the vials tightly and shake thoroughly to dissolve the powder.

Note: A green color will develop if ammonia is present.

8. Press:

TIMER ENTER

A 20-minute reaction period will begin.

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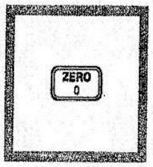
* Adapted from *Clin. Chim. Acta,* 14 403 (1966).

NITROGEN, AMMONIA, Low Range, Test 'N Tube, continued

9. Wipe the outside of the vials with a towel. After the timer beeps, place the blank into the adapter. Tightly cover the vial with the instrument cap.

Note: Wipe with a damp cloth followed by a dry one to remove fingerprints and other marks.



10. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.00 mg/L NH3-N

11. Place the prepared sample in the adapter.

Push straight down on the top of the vial until it seats solidly into the adapter.

Note: Do not move the vial from side to side as this can cause errors.

12. Tightly cover the sample cell with the instrument cap.

Press: **READ**

The cursor will move to the right, then the result in mg/L ammonia nitrogen will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Standard Adjust (Adjusting the Standard Curve) on page 47).

Sampling and Storage

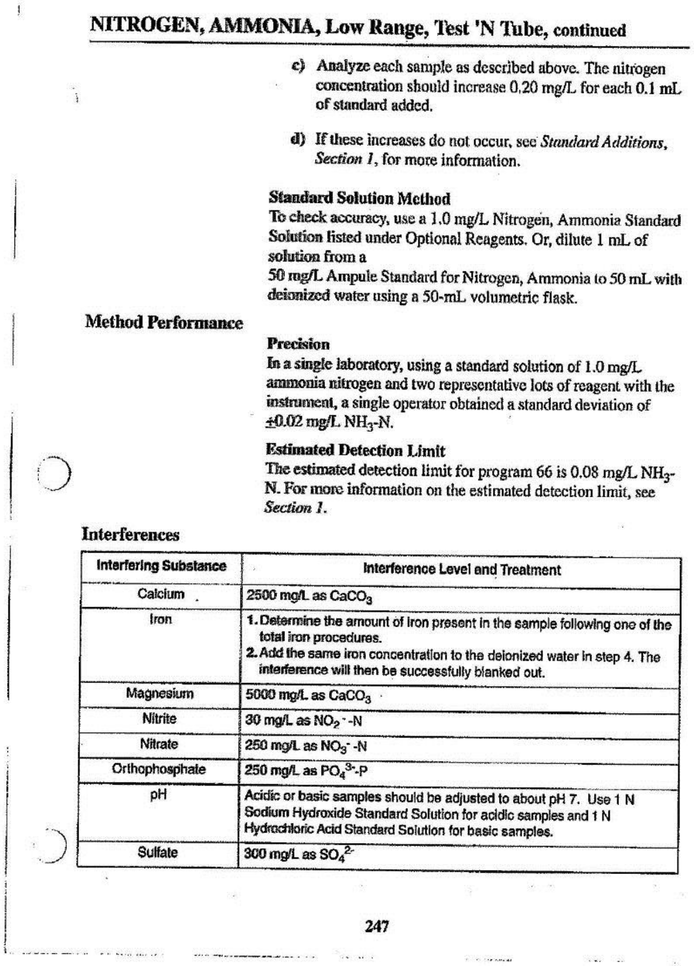
Collect samples in clean plastic or glass bottles. Best results are obtained with immediate analysis. If chlorine is known to be present, add one drop of 0.1 N sodium thiosulfate for each 0.3 mg/L Cl_2 in a one liter sample. Preserve the sample by reducing the pH to 2 or less with hydrochloric acid (at least 2 mL). Store at 4 °C (39 °F) or less. Preserved samples may be stored up to 28 days. Before analysis, warm samples to room temperature and neutralize with 5.0 N sodium hydroxide. Correct the test result for volume additions. See *Correcting for Volume Additions on page 22* for more information.

Accuracy Check

Standard Additions Method

a) Snap the neck off a Nitrogen, Ammonia Ampule Standard Solution, 50 mg/L NH_3-N.

b) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25 mL samples. Mix thoroughly.



NITROGEN, AMMONIA, Low Range, Test 'N Tube, continued

c) Analyze each sample as described above. The nitrogen concentration should increase 0.20 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions, Section 1*, for more information.

Standard Solution Method

To check accuracy, use a 1.0 mg/L Nitrogen, Ammonia Standard Solution listed under Optional Reagents. Or, dilute 1 mL of solution from a
50 mg/L Ampule Standard for Nitrogen, Ammonia to 50 mL with deionized water using a 50-mL volumetric flask.

Method Performance

Precision

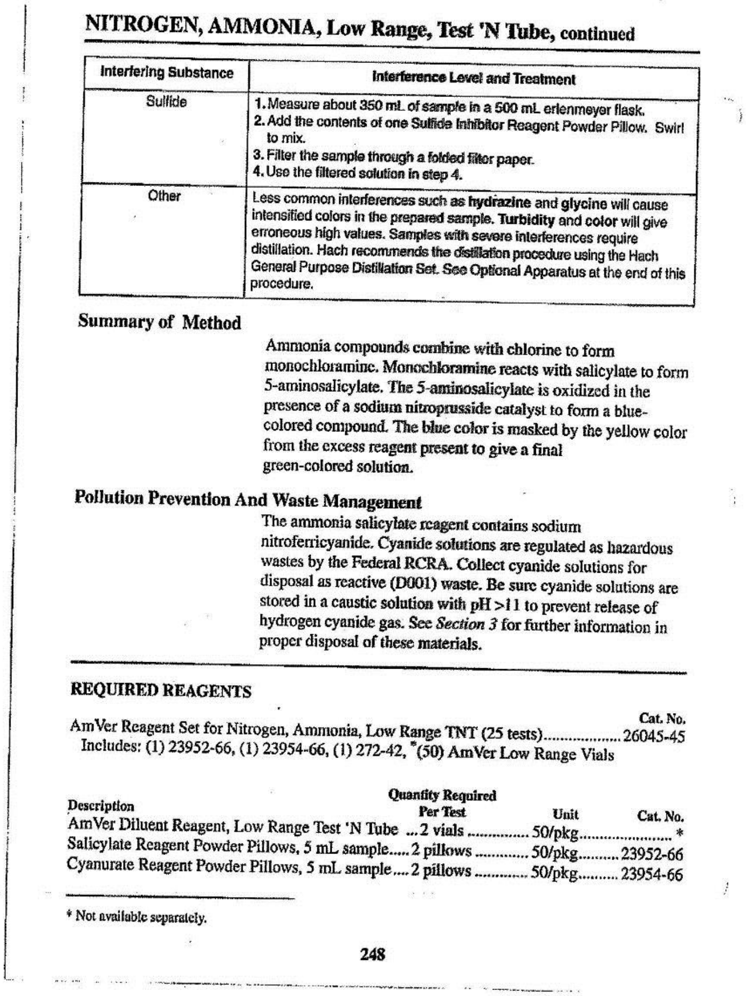
In a single laboratory, using a standard solution of 1.0 mg/L ammonia nitrogen and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of ±0.02 mg/L NH_3-N.

Estimated Detection Limit

The estimated detection limit for program 66 is 0.08 mg/L NH_3-N. For more information on the estimated detection limit, see *Section 1*.

Interferences

Interfering Substance	Interference Level and Treatment
Calcium	2500 mg/L as $CaCO_3$
Iron	1. Determine the amount of iron present in the sample following one of the total iron procedures. 2. Add the same iron concentration to the deionized water in step 4. The interference will then be successfully blanked out.
Magnesium	5000 mg/L as $CaCO_3$
Nitrite	30 mg/L as NO_2^--N
Nitrate	250 mg/L as NO_3^--N
Orthophosphate	250 mg/L as PO_4^{3-}-P
pH	Acidic or basic samples should be adjusted to about pH 7. Use 1 N Sodium Hydroxide Standard Solution for acidic samples and 1 N Hydrochloric Acid Standard Solution for basic samples.
Sulfate	300 mg/L as SO_4^{2-}



NITROGEN, AMMONIA, Low Range, Test 'N Tube, continued

Interfering Substance	Interference Level and Treatment
Sulfide	1. Measure about 350 mL of sample in a 500 mL erlenmeyer flask. 2. Add the contents of one Sulfide Inhibitor Reagent Powder Pillow. Swirl to mix. 3. Filter the sample through a folded filter paper. 4. Use the filtered solution in step 4.
Other	Less common interferences such as **hydrazine** and **glycine** will cause intensified colors in the prepared sample. **Turbidity** and **color** will give erroneous high values. Samples with severe interferences require distillation. Hach recommends the distillation procedure using the Hach General Purpose Distillation Set. See Optional Apparatus at the end of this procedure.

Summary of Method

Ammonia compounds combine with chlorine to form monochloramine. Monochloramine reacts with salicylate to form 5-aminosalicylate. The 5-aminosalicylate is oxidized in the presence of a sodium nitroprusside catalyst to form a blue-colored compound. The blue color is masked by the yellow color from the excess reagent present to give a final green-colored solution.

Pollution Prevention And Waste Management

The ammonia salicylate reagent contains sodium nitroferricyanide. Cyanide solutions are regulated as hazardous wastes by the Federal RCRA. Collect cyanide solutions for disposal as reactive (D001) waste. Be sure cyanide solutions are stored in a caustic solution with pH >11 to prevent release of hydrogen cyanide gas. See *Section 3* for further information in proper disposal of these materials.

REQUIRED REAGENTS

	Cat. No.
AmVer Reagent Set for Nitrogen, Ammonia, Low Range TNT (25 tests)	26045-45
Includes: (1) 23952-66, (1) 23954-66, (1) 272-42, *(50) AmVer Low Range Vials	

Description	Quantity Required Per Test	Unit	Cat. No.
AmVer Diluent Reagent, Low Range Test 'N Tube	2 vials	50/pkg	*
Salicylate Reagent Powder Pillows, 5 mL sample	2 pillows	50/pkg	23952-66
Cyanurate Reagent Powder Pillows, 5 mL sample	2 pillows	50/pkg	23954-66

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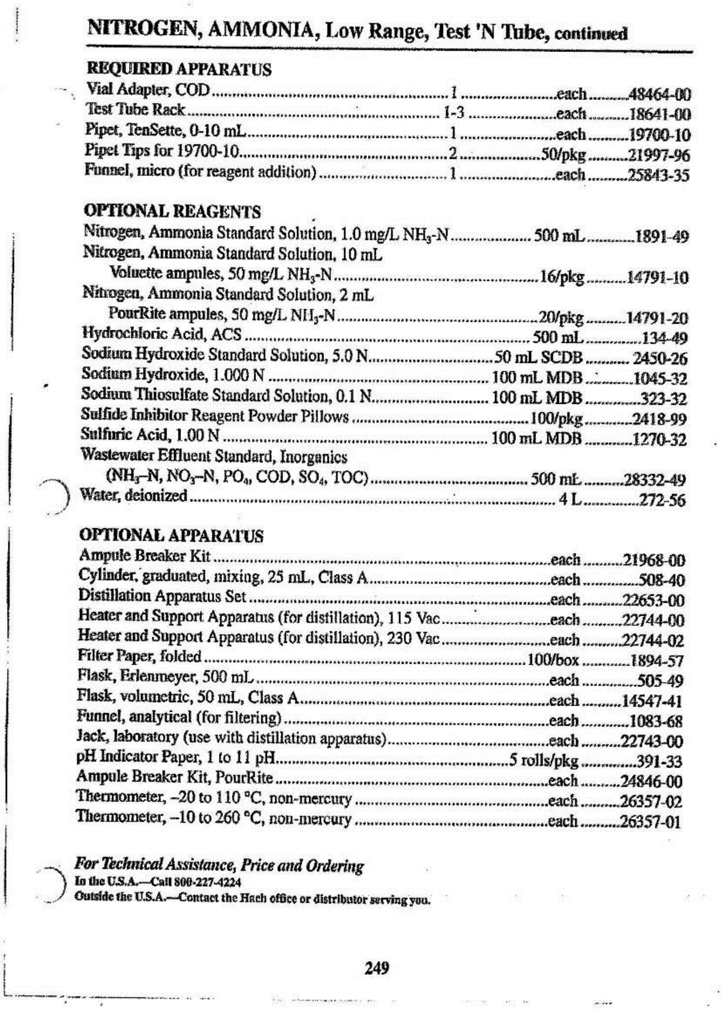
* Not available separately.



NITROGEN, AMMONIA, Low Range, Test 'N Tube, continued

REQUIRED APPARATUS

Vial Adapter, COD	1	each	48464-00
Test Tube Rack	1-3	each	18641-00
Pipet, TenSette, 0-10 mL	1	each	19700-10
Pipet Tips for 19700-10	2	50/pkg	21997-96
Funnel, micro (for reagent addition)	1	each	25843-35

OPTIONAL REAGENTS

Nitrogen, Ammonia Standard Solution, 1.0 mg/L NH_3-N	500 mL	1891-49
Nitrogen, Ammonia Standard Solution, 10 mL Voluette ampules, 50 mg/L NH_3-N	16/pkg	14791-10
Nitrogen, Ammonia Standard Solution, 2 mL PourRite ampules, 50 mg/L NH_3-N	20/pkg	14791-20
Hydrochloric Acid, ACS	500 mL	134-49
Sodium Hydroxide Standard Solution, 5.0 N	50 mL SCDB	2450-26
Sodium Hydroxide, 1.000 N	100 mL MDB	1045-32
Sodium Thiosulfate Standard Solution, 0.1 N	100 mL MDB	323-32
Sulfide Inhibitor Reagent Powder Pillows	100/pkg	2418-99
Sulfuric Acid, 1.00 N	100 mL MDB	1270-32
Wastewater Effluent Standard, Inorganics (NH_3–N, NO_3–N, PO_4, COD, SO_4, TOC)	500 mL	28332-49
Water, deionized	4 L	272-56

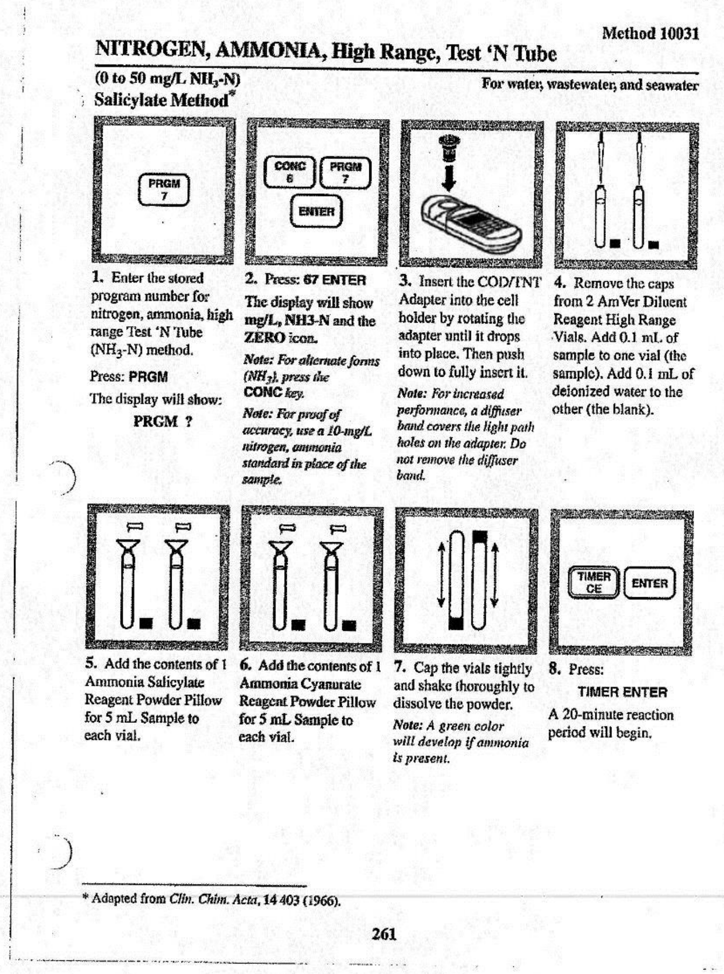
OPTIONAL APPARATUS

Ampule Breaker Kit	each	21968-00
Cylinder, graduated, mixing, 25 mL, Class A	each	508-40
Distillation Apparatus Set	each	22653-00
Heater and Support Apparatus (for distillation), 115 Vac	each	22744-00
Heater and Support Apparatus (for distillation), 230 Vac	each	22744-02
Filter Paper, folded	100/box	1894-57
Flask, Erlenmeyer, 500 mL	each	505-49
Flask, volumetric, 50 mL, Class A	each	14547-41
Funnel, analytical (for filtering)	each	1083-68
Jack, laboratory (use with distillation apparatus)	each	22743-00
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
Ampule Breaker Kit, PourRite	each	24846-00
Thermometer, –20 to 110 °C, non-mercury	each	26357-02
Thermometer, –10 to 260 °C, non-mercury	each	26357-01

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.



Method 10031

NITROGEN, AMMONIA, High Range, Test 'N Tube

(0 to 50 mg/L NH_3-N)

For water, wastewater, and seawater

Salicylate Method*

1. Enter the stored program number for nitrogen, ammonia, high range Test 'N Tube (NH_3-N) method.

Press: **PRGM**

The display will show:

PRGM ?

2. Press: **67 ENTER**

The display will show **mg/L, NH3-N** and the **ZERO** icon.

Note: For alternate forms (NH_3), press the **CONC** *key.*

Note: For proof of accuracy, use a 10-mg/L nitrogen, ammonia standard in place of the sample.

3. Insert the COD/TNT Adapter into the cell holder by rotating the adapter until it drops into place. Then push down to fully insert it.

Note: For increased performance, a diffuser band covers the light path holes on the adapter. Do not remove the diffuser band.

4. Remove the caps from 2 AmVer Diluent Reagent High Range Vials. Add 0.1 mL of sample to one vial (the sample). Add 0.1 mL of deionized water to the other (the blank).

5. Add the contents of 1 Ammonia Salicylate Reagent Powder Pillow for 5 mL Sample to each vial.

6. Add the contents of 1 Ammonia Cyanurate Reagent Powder Pillow for 5 mL Sample to each vial.

7. Cap the vials tightly and shake thoroughly to dissolve the powder.

Note: A green color will develop if ammonia is present.

8. Press:

TIMER ENTER

A 20-minute reaction period will begin.

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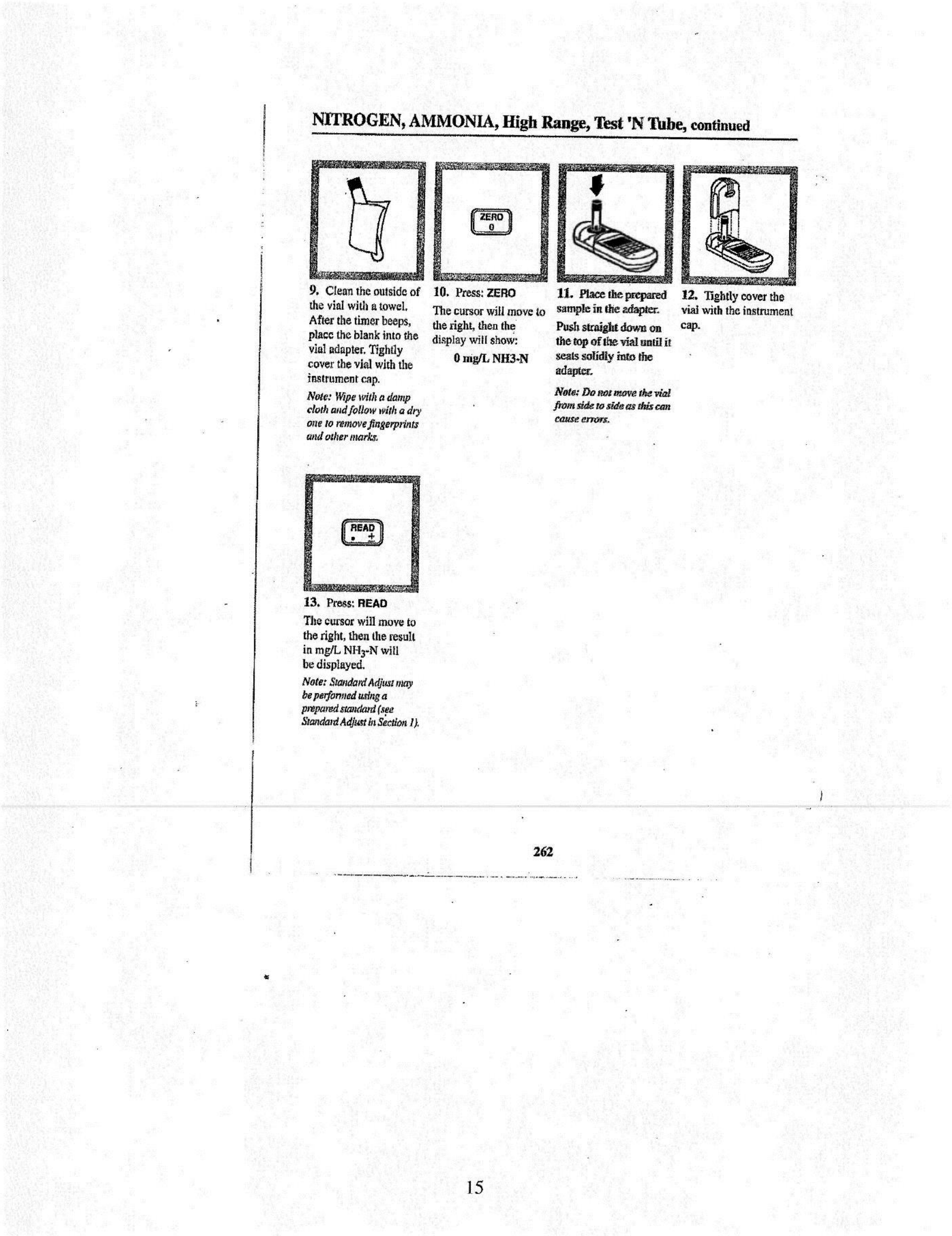
* Adapted from *Clin. Chim. Acta*, 14 403 (1966).



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

9. Clean the outside of the vial with a towel. After the timer beeps, place the blank into the vial adapter. Tightly cover the vial with the instrument cap.

Note: Wipe with a damp cloth and follow with a dry one to remove fingerprints and other marks.

10. Press: **ZERO**

The cursor will move to the right, then the display will show:

0 mg/L NH3-N

11. Place the prepared sample in the adapter.

Push straight down on the top of the vial until it seats solidly into the adapter.

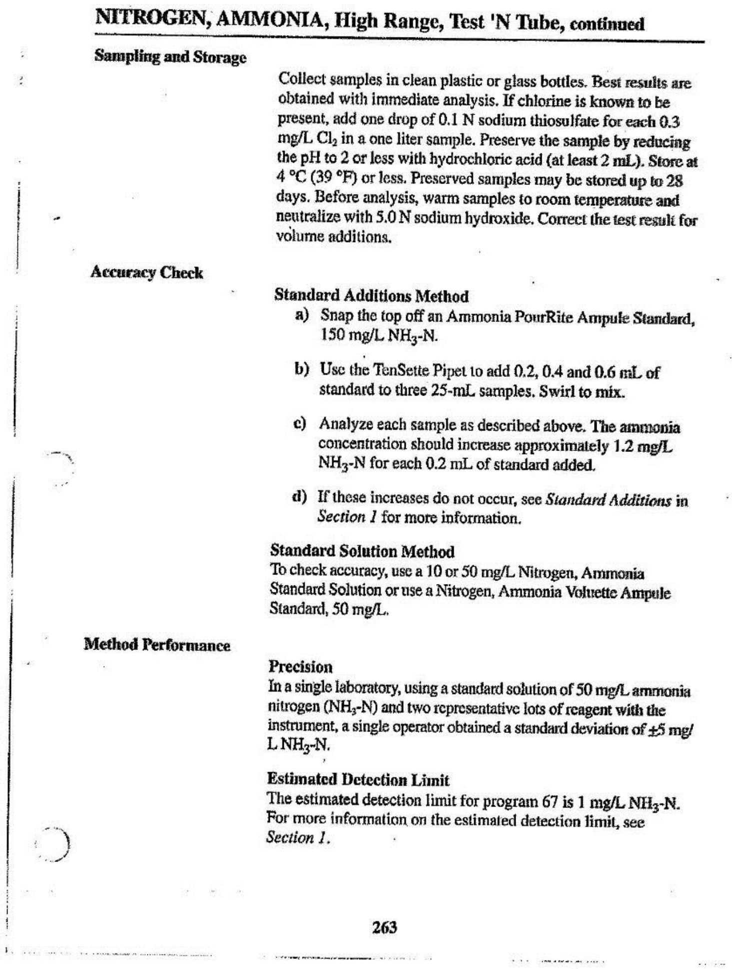
Note: Do not move the vial from side to side as this can cause errors.

12. Tightly cover the vial with the instrument cap.

13. Press: **READ**

The cursor will move to the right, then the result in mg/L NH_3-N will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

Sampling and Storage

Collect samples in clean plastic or glass bottles. Best results are obtained with immediate analysis. If chlorine is known to be present, add one drop of 0.1 N sodium thiosulfate for each 0.3 mg/L Cl_2 in a one liter sample. Preserve the sample by reducing the pH to 2 or less with hydrochloric acid (at least 2 mL). Store at 4 °C (39 °F) or less. Preserved samples may be stored up to 28 days. Before analysis, warm samples to room temperature and neutralize with 5.0 N sodium hydroxide. Correct the test result for volume additions.

Accuracy Check

Standard Additions Method

a) Snap the top off an Ammonia PourRite Ampule Standard, 150 mg/L NH_3-N.

b) Use the TenSette Pipet to add 0.2, 0.4 and 0.6 mL of standard to three 25-mL samples. Swirl to mix.

c) Analyze each sample as described above. The ammonia concentration should increase approximately 1.2 mg/L NH_3-N for each 0.2 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Solution Method

To check accuracy, use a 10 or 50 mg/L Nitrogen, Ammonia Standard Solution or use a Nitrogen, Ammonia Voluette Ampule Standard, 50 mg/L.

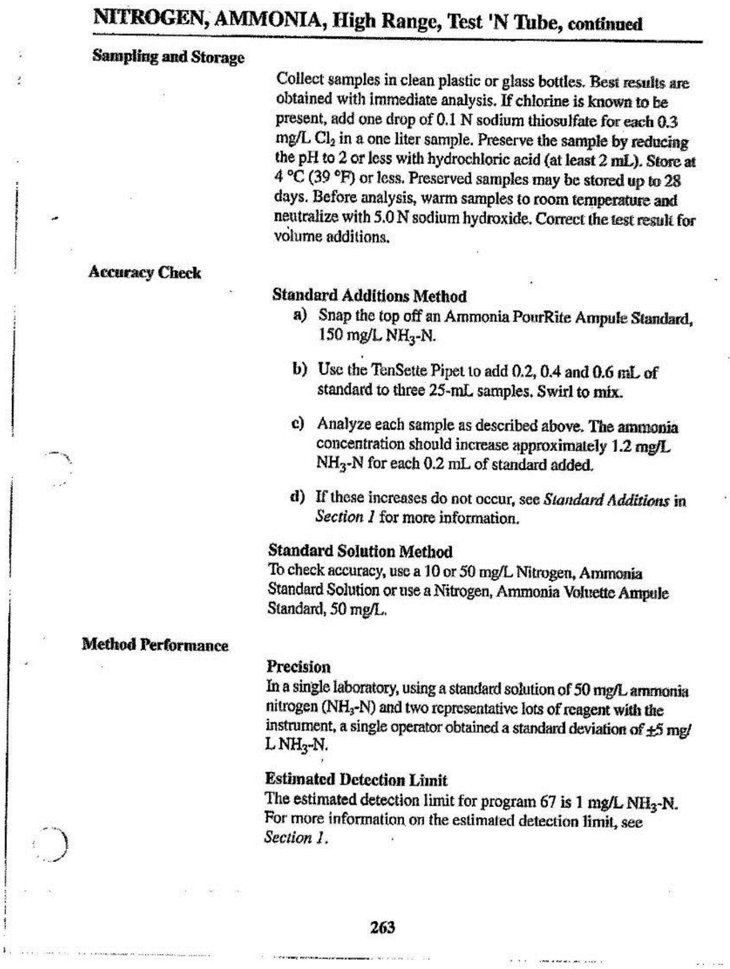
Method Performance

Precision

In a single laboratory, using a standard solution of 50 mg/L ammonia nitrogen (NH_3-N) and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of ±5 mg/L NH_3-N.

Estimated Detection Limit

The estimated detection limit for program 67 is 1 mg/L NH_3-N. For more information on the estimated detection limit, see *Section 1*.



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

Sampling and Storage

Collect samples in clean plastic or glass bottles. Best results are obtained with immediate analysis. If chlorine is known to be present, add one drop of 0.1 N sodium thiosulfate for each 0.3 mg/L Cl_2 in a one liter sample. Preserve the sample by reducing the pH to 2 or less with hydrochloric acid (at least 2 mL). Store at 4 °C (39 °F) or less. Preserved samples may be stored up to 28 days. Before analysis, warm samples to room temperature and neutralize with 5.0 N sodium hydroxide. Correct the test result for volume additions.

Accuracy Check

Standard Additions Method

a) Snap the top off an Ammonia PourRite Ampule Standard, 150 mg/L NH_3-N.

b) Use the TenSette Pipet to add 0.2, 0.4 and 0.6 mL of standard to three 25-mL samples. Swirl to mix.

c) Analyze each sample as described above. The ammonia concentration should increase approximately 1.2 mg/L NH_3-N for each 0.2 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Solution Method

To check accuracy, use a 10 or 50 mg/L Nitrogen, Ammonia Standard Solution or use a Nitrogen, Ammonia Voluette Ampule Standard, 50 mg/L.

Method Performance

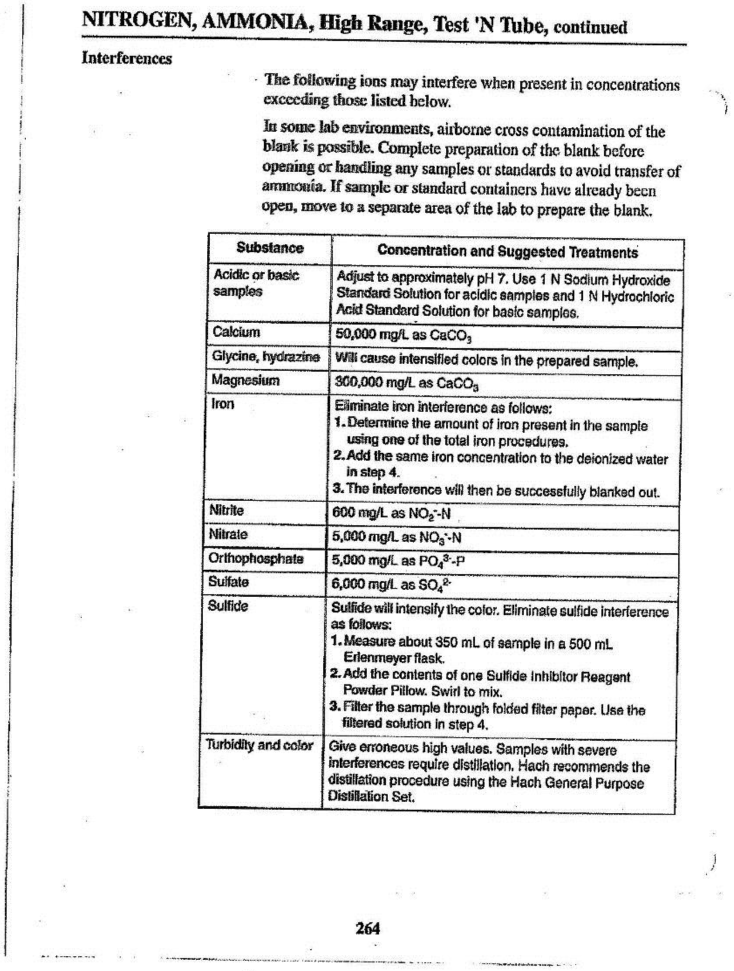
Precision

In a single laboratory, using a standard solution of 50 mg/L ammonia nitrogen (NH_3-N) and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of ±5 mg/L NH_3-N.

Estimated Detection Limit

The estimated detection limit for program 67 is 1 mg/L NH_3-N. For more information on the estimated detection limit, see *Section 1*.

263



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

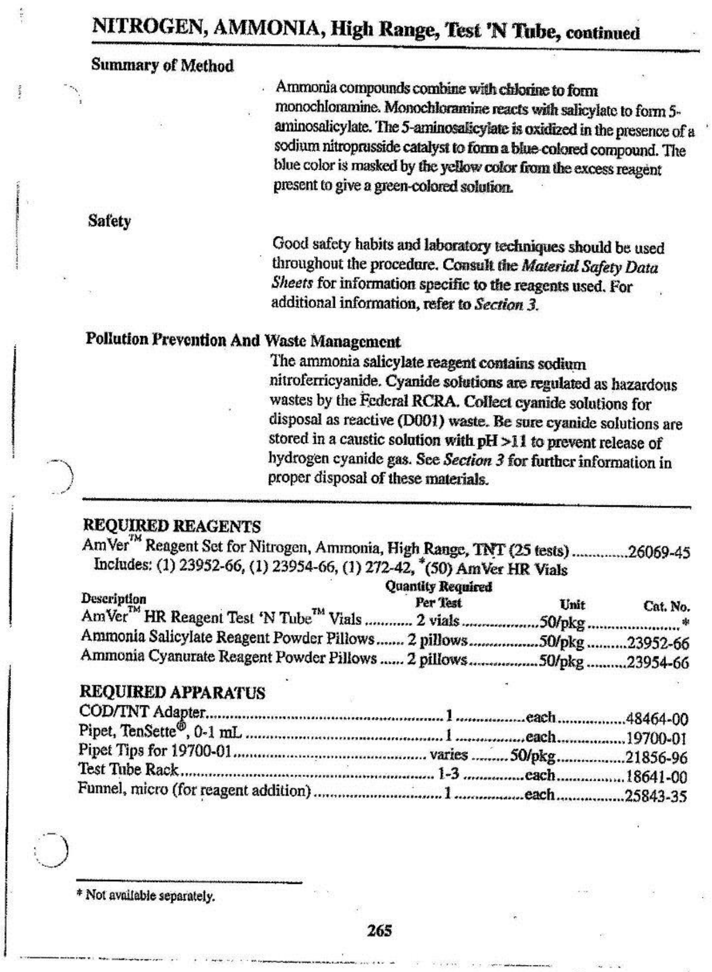
Interferences

The following ions may interfere when present in concentrations exceeding those listed below.

In some lab environments, airborne cross contamination of the blank is possible. Complete preparation of the blank before opening or handling any samples or standards to avoid transfer of ammonia. If sample or standard containers have already been open, move to a separate area of the lab to prepare the blank.

Substance	Concentration and Suggested Treatments
Acidic or basic samples	Adjust to approximately pH 7. Use 1 N Sodium Hydroxide Standard Solution for acidic samples and 1 N Hydrochloric Acid Standard Solution for basic samples.
Calcium	50,000 mg/L as $CaCO_3$
Glycine, hydrazine	Will cause intensified colors in the prepared sample.
Magnesium	300,000 mg/L as $CaCO_3$
Iron	Eliminate iron interference as follows: 1. Determine the amount of iron present in the sample using one of the total iron procedures. 2. Add the same iron concentration to the deionized water in step 4. 3. The interference will then be successfully blanked out.
Nitrite	600 mg/L as NO_2^--N
Nitrate	5,000 mg/L as NO_3^--N
Orthophosphate	5,000 mg/L as PO_4^{3-}-P
Sulfate	6,000 mg/L as SO_4^{2-}
Sulfide	Sulfide will intensify the color. Eliminate sulfide interference as follows: 1. Measure about 350 mL of sample in a 500 mL Erlenmeyer flask. 2. Add the contents of one Sulfide Inhibitor Reagent Powder Pillow. Swirl to mix. 3. Filter the sample through folded filter paper. Use the filtered solution in step 4.
Turbidity and color	Give erroneous high values. Samples with severe interferences require distillation. Hach recommends the distillation procedure using the Hach General Purpose Distillation Set.

264



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

Summary of Method

Ammonia compounds combine with chlorine to form monochloramine. Monochloramine reacts with salicylate to form 5-aminosalicylate. The 5-aminosalicylate is oxidized in the presence of a sodium nitroprusside catalyst to form a blue-colored compound. The blue color is masked by the yellow color from the excess reagent present to give a green-colored solution.

Safety

Good safety habits and laboratory techniques should be used throughout the procedure. Consult the *Material Safety Data Sheets* for information specific to the reagents used. For additional information, refer to *Section 3.*

Pollution Prevention And Waste Management

The ammonia salicylate reagent contains sodium nitroferricyanide. Cyanide solutions are regulated as hazardous wastes by the Federal RCRA. Collect cyanide solutions for disposal as reactive (D001) waste. Be sure cyanide solutions are stored in a caustic solution with pH >11 to prevent release of hydrogen cyanide gas. See *Section 3* for further information in proper disposal of these materials.

REQUIRED REAGENTS

AmVer™ Reagent Set for Nitrogen, Ammonia, High Range, TNT (25 tests) 26069-45

Includes: (1) 23952-66, (1) 23954-66, (1) 272-42, *(50) AmVer HR Vials

Description	Quantity Required Per Test	Unit	Cat. No.
AmVer™ HR Reagent Test 'N Tube™ Vials	2 vials	50/pkg	*
Ammonia Salicylate Reagent Powder Pillows	2 pillows	50/pkg	23952-66
Ammonia Cyanurate Reagent Powder Pillows	2 pillows	50/pkg	23954-66

REQUIRED APPARATUS

COD/TNT Adapter	1	each	48464-00
Pipet, TenSette®, 0-1 mL	1	each	19700-01
Pipet Tips for 19700-01	varies	50/pkg	21856-96
Test Tube Rack	1-3	each	18641-00
Funnel, micro (for reagent addition)	1	each	25843-35

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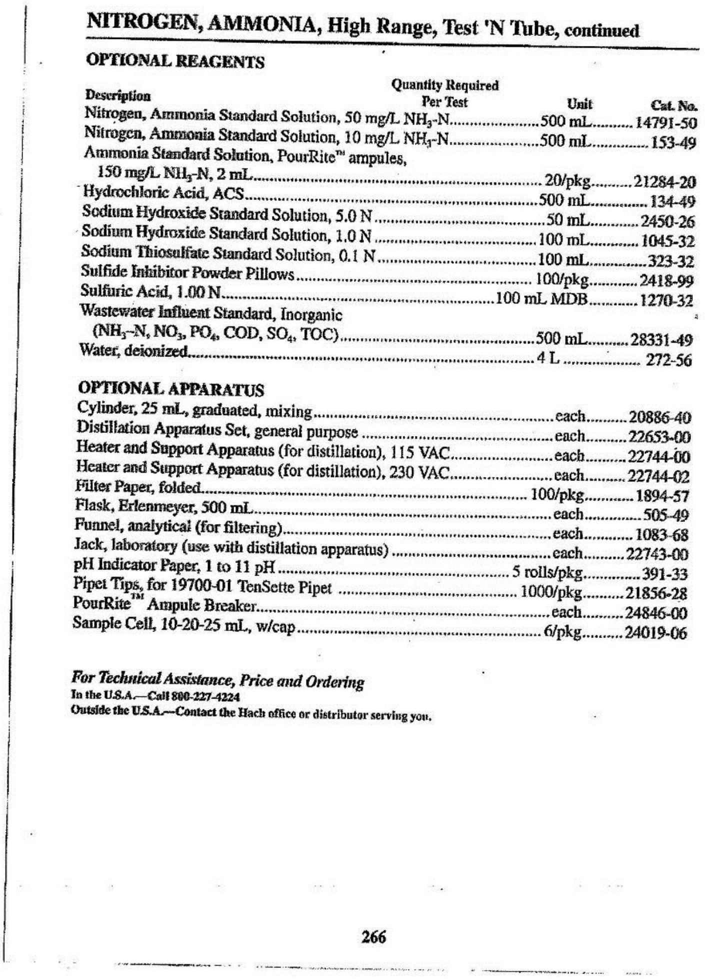
* Not available separately.



NITROGEN, AMMONIA, High Range, Test 'N Tube, continued

OPTIONAL REAGENTS

Description	Quantity Required Per Test	Unit	Cat. No.
Nitrogen, Ammonia Standard Solution, 50 mg/L NH_3-N		500 mL	14791-50
Nitrogen, Ammonia Standard Solution, 10 mg/L NH_3-N		500 mL	153-49
Ammonia Standard Solution, PourRite™ ampules, 150 mg/L NH_3-N, 2 mL		20/pkg	21284-20
Hydrochloric Acid, ACS		500 mL	134-49
Sodium Hydroxide Standard Solution, 5.0 N		50 mL	2450-26
Sodium Hydroxide Standard Solution, 1.0 N		100 mL	1045-32
Sodium Thiosulfate Standard Solution, 0.1 N		100 mL	323-32
Sulfide Inhibitor Powder Pillows		100/pkg	2418-99
Sulfuric Acid, 1.00 N		100 mL MDB	1270-32
Wastewater Influent Standard, Inorganic (NH_3–N, NO_3, PO_4, COD, SO_4, TOC)		500 mL	28331-49
Water, deionized		4 L	272-56

OPTIONAL APPARATUS

Cylinder, 25 mL, graduated, mixing		each	20886-40
Distillation Apparatus Set, general purpose		each	22653-00
Heater and Support Apparatus (for distillation), 115 VAC		each	22744-00
Heater and Support Apparatus (for distillation), 230 VAC		each	22744-02
Filter Paper, folded		100/pkg	1894-57
Flask, Erlenmeyer, 500 mL		each	505-49
Funnel, analytical (for filtering)		each	1083-68
Jack, laboratory (use with distillation apparatus)		each	22743-00
pH Indicator Paper, 1 to 11 pH		5 rolls/pkg	391-33
Pipet Tips, for 19700-01 TenSette Pipet		1000/pkg	21856-28
PourRite™ Ampule Breaker		each	24846-00
Sample Cell, 10-20-25 mL, w/cap		6/pkg	24019-06

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.