

Capacity Assurance Program

for

City of Cookeville, Tennessee
Department of Water Quality Control

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DEFINITIONS

Average Daily Flow – average flow during dry weather

CAP – Capacity Assurance Program

Category I Non-Compliance – not in compliance for quarterly reporting as defined in 40 CFR Part 123.45, Appendix A

Collector Sewer – sewer lines that feed into a trunk sewer

Critical Basin – a sewer basin that experiences more than five overflows per year at the design storm or less

Design Storm – a 2-year 24-hour rainfall event as defined by the National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server

Developer – the person requesting new sewer service

Interceptor – main sewer that feeds into the wastewater treatment plant

One-Hour Peak Flow – the maximum flow during a 2-year - 24-hour rainfall event as defined by the National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server

Pump Station – the actual pumping station and the associated force main

Reoccurring Overflow – an overflow that occurs more than five times in a calendar year

Riparian Zone – areas along or under the influence of watercourses and waterbodies that are strongly influenced by free or unbound water in the soil

Surcharged Condition - a surcharged sewer is defined as a manhole without a watertight cover with a water surface level within 12-inches of the manhole rim.

Trunk Sewer – main sewer line that feeds into a pump station or interceptor

Wet Weather Surcharge Condition – surcharge of a manhole to within one foot of the manhole rim, excluding watertight manholes, during the one-hour peak flow

WQC – the City of Cookeville Department of Water Quality Control

WWTP – Wastewater Treatment Plant

EXECUTIVE SUMMARY

As with most sewer systems, certain areas of Cookeville experience occasional sanitary sewer overflows (SSOs). These overflows are generally caused by aging infrastructure resulting in leaking pipes and illegal connection of stormwater drains to the sewer system, and primarily occur during wet weather. The City of Cookeville (City) has a program to fix leaking sewers and identify stormwater drain connections. This program is ongoing, and it may take years to see significant results.

While new connections do not directly cause SSOs, they do contribute some amount of additional flow to the sewer system. The City is dedicated to eliminating wet weather SSOs to protect public health while allowing new connections that drive the economic growth necessary for a thriving community. For those reasons, the City utilizes this Capacity Assurance Program (CAP) to make decisions regarding new connections to the sanitary sewer system in areas that are experiencing wet weather SSOs.

This CAP provides a systematic approach for evaluating the ability of the collection, transmission, and treatment system to accommodate additional flow so that worsening of existing overflows or creating additional overflows is avoided. The protocols contained in this document are used to evaluate requests for new connections or increases in existing connections in sewer basins that are experiencing wet weather overflows, and are not intended to evaluate the capacity of the system to transport and treat average daily flow (ADF).

SECTION 1 – INTRODUCTION AND OVERVIEW

1.1 PURPOSE OF THE CAPACITY ASSURANCE PROGRAM

The City understands the need to balance economic growth with the ability of infrastructure to handle that growth. This CAP is a tool to assist the City in determining if new sewer connections or increased flow from existing sewer connections will result in new or increased SSOs during wet weather. This CAP provides a systematic approach for evaluating the wet weather sewer system capacity. These procedures are used to evaluate wet weather impacts only and are not intended to evaluate the ability of the system to transport and treat average daily flow.

1.2 SYSTEM OVERVIEW

The City of Cookeville Department of Water Quality Control provides wastewater collection and treatment service to approximately 14,500 customers in the greater Cookeville area. The collection and treatment system consists of approximately 230 miles of sewers, 21 pump stations, and one 14-MGD WWTP.

The City has a primary goal of eliminating all wet weather overflows in the system and a secondary goal of reducing infiltration and inflow (I&I) to acceptable levels. To meet this goal, the City established an ongoing program to reduce wet weather flows that includes the following components:

- Periodic flow monitoring
- TV inspection of sewers in problem areas
- Rehabilitation of sewers identified as needing repair
- Lateral replacement in areas where rehabilitation did not accomplish the wet weather flow reduction goal

SECTION 2 – CAPACITY ASSESSMENT PROCEDURES

2.1 OVERVIEW

The CAP protocol is followed for critical basins, which are defined as basins that experience more than five overflows per year at the design storm or less. The CAP is used only for new residential development or infill that adds more than four residences, and for new service or increases in discharge from commercial, institutional, or industrial customers of more than 10%. The CAP is not used for single residence connections that are not part of a development or for infill that adds four residences or less.

The City certifies that the system has adequate capacity if it can transport and treat the existing one-hour peak flow event in addition to the predicted one-hour peak flow from the proposed new connection(s) without causing a surcharged condition. The one-hour peak flow event is defined as the maximum one-hour flow during a 2-year – 24-hour rainfall event per the National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server. If the particular sewer is included in the existing sewer system model, the model will be used to predict the one-hour peak flow event. If the sewer is not included in the model, recent flow monitoring results will be used to estimate the one-hour peak flow. If neither modeling or flow monitoring data are available, depth of flow measurements and/or best engineering judgement by Cookeville staff will be used to estimate the one-hour peak flow event.

The peak to annual average flow ratio is calculated from Figure 1 in Chapter 10 of *Recommended Standards for Wastewater Facilities* (Ten State Standards), latest edition.

Average daily wastewater flow is calculated using the actual residential customers served, 100 gallons per capita per day (gpcpd) and the most recent census data for persons per household. This calculation includes an allowance for normal infiltration. Commercial, Industrial and Institutional wastewater flow is assumed to be equal to the water sold to these customers.

System capacity calculations are reviewed at least annually and updated whenever significant changes have occurred, such as construction of new trunk sewers or pump stations. Used Capacity is updated annually. New service commitments and requests are continually tracked.

The Available Capacity is tracked for each critical basin using a spreadsheet. Calculation of each part of the capacity equation is described below.

2.2 WASTEWATER TREATMENT PLANT (WWTP) CAPACITY ASSESSMENT PROCEDURE

2.2.1 Total Capacity

The wet weather flow capacity of the WWTP is equal to the peak day design flow from the Design Memorandum from the latest plant upgrade or from the maximum flow that the plant can treat without Category I Non-Compliance, whichever is greater.

2.2.2 Used Capacity

The Used Capacity of the WWTP is equal to the maximum day flow from the previous calendar year not resulting from a greater than 2-year – 24-hour storm.

2.3 SEWER CAPACITY ASSESSMENT PROCEDURE

2.3.1 Total Capacity

The Total Capacity of a sewer line segment is equal to the calculated capacity of the unsurcharged sewer. For the purposes of the CAP, a surcharged sewer is defined as a non-watertight manhole with a water surface level within 12-inches of the manhole rim. Total Capacity for sewer segments designed to operate under pressure, such as manholes with watertight covers, is calculated using the design criteria for that particular sewer segment.

2.3.2 Used Capacity

The Used Capacity of the sewer line segment is calculated from existing flow data based on the one-hour peak flow event as previously described.

2.4 PUMP STATION CAPACITY ASSESSMENT PROCEDURE

2.2.1 Total Capacity

The total capacity of a pumping station is equal to the pumping capacity with the largest pump out of service.

2.2.2 Used Capacity

The used capacity of a pump station is the flow that occurs during a one-hour peak event as previously described. This flow is calculated using flow metering when available. When not available, flow is calculated using pump run times and pump capacity.

2.5 NEW SERVICE COMMITMENTS

New Service Commitments are new requests for sewer service that have commitment letters issued by the City. New Service Commitments are valid for one year unless otherwise noted in the commitment letter. This section describes how flows from new services are calculated.

2.5.1 Flow Calculation

For new Residential connections, the annual average flow contribution is calculated based on the flow per person, the average persons per household, and the total residential units. The flow per capita is 100 gallons per person per day per the *Recommended Standards for Wastewater Facilities* (Ten State Standards), latest edition. The persons per household is taken from the latest census data. Links to this information can be found in the Appendix. The one-hour peak event flow is calculated by multiplying the annual average flow by a peaking factor of 3.

For Commercial, Industrial and Institutional flows, the annual average flow contribution is calculated using the latest edition of the TDEC *Design Criteria for Sewage Works* or acceptable calculations from the proposed facility's engineer. A copy of the TDEC information is included in the Appendix.

2.6 AVAILABLE CAPACITY AND CERTIFICATION

The Available Capacity is the portion of the capacity that is remaining for new service. This section describes how the Available Capacity is calculated.

The Available Capacity is calculated by the following formula:

$$\text{Available Capacity} = \text{Total Capacity} - \text{Used Capacity} - \text{New Service Commitments}$$

This formula applies to each component of the system.

The system is certified as having adequate capacity if the Total Capacity is less than the used capacity plus the New Service Commitments.

2.6.1 Approval in Lieu of Certification

If the City cannot certify that the system has adequate capacity for the proposed additional flow, the City may allow the additional flow through Approval in Lieu of Certification. This process takes into account flow reductions realized by completed rehabilitation projects.

Capacity Credits can be accumulated when a flow reduction, capacity enhancement or rehabilitation project is completed in a sewer basin. For each gallon per day (gpd) of flow reduction or capacity enhancement, a credit of 0.5 gpd can be taken. Capacity Credits earned in a basin can be applied to offset additional flow from new services in the basin when available.

The City maintains a Capacity Credit Bank to track Capacity Credits accumulated and used in each basin. Credits cannot be accumulated or used until the flow reduction, capacity enhancement or rehabilitation project is complete. The Capacity Credit Bank includes all rehabilitation completed after June 1, 2016. Capacity Credits are calculated for the peak hour flow.

Capacity Credits are used entirely at the discretion of the City.

2.6.1.1 Flow Reduction

Flow reduction credits are taken as a result of a decrease in peak hour discharge from a specific customer or customers. For example, if an Industrial User completes a project that reduces their total peak hour discharge to the sewer system, half of the amount of the reduction is added to the Capacity Credit Bank.

2.6.1.2 Capacity Enhancement

Off-line storage basins are considered capacity enhancing projects. For every gallon of off-line storage added, one gallon per day of capacity is added to the Capacity Credit Bank.

2.6.1.3 Rehabilitation Projects

For large sewer system rehabilitation projects, flow monitoring before and after the project is used to determine the flow reduction. Half of the reduction in flow for the one-hour storm event is added to the Capacity Credit Bank upon completion of flow monitoring.

For smaller projects where flow monitoring is not feasible, flow reduction is calculated as follows:

- **Manholes** – Flow reduction for various repairs will be taken in accordance with ASCE Manual of Practice No. 92 as reproduced in the Appendix. Capacity Credit is equal to half of the flow rate reduction.
- **Removal of Inflow Sources** – the following Capacity Credits will be taken for removal of inflow sources:

Downspout	4,000 gpd per downspout
Driveway Drain	6,000 gpd per driveway drain
Foundation Drain	4,000 gpd per drain
Sump Pump	Half the capacity of the pump
Defective or Missing Cleanout Lid	180 gpd per cleanout lid replaced

- **Rehabilitation of Mainline Sewers and Private Laterals** – the following Capacity Credits will be taken for rehabilitation of mainline sewers and private laterals:

Riparian Zones	34,000 gpd per inch-mile of pipe
Non-Riparian Zones	3,400 gpd per inch-mile of pipe

- **Point Source Repairs** – the Capacity Credit is half of the estimated flow through the hole or defect.

2.7 INFORMATION MANAGEMENT

This section describes how Total Capacity, Used Capacity and New Service Commitments are tracked.

The City uses its GIS to track information related to the CAP. Information tracked in the GIS system includes:

- **SSOs**
- **Sewer system rehabilitation and line segment replacement**
- **New service requests**
- **Sewer segment diameter, length and slope used to calculate capacity**

In addition, the City maintains spreadsheets that track the use of Capacity Credits in each critical drainage basin and the number and status of new service requests.

SECTION 3 – CAPACITY CERTIFICATION PROTOCOLS

3.1 OVERVIEW

The purpose of the CAP is to provide a method for assuring that capacity is available to transport and treat the wet weather flow from new services. This section describes the protocols that are used to assure that capacity is available.

3.2 CERTIFICATION PROTOCOL

The Certification Protocol flow chart is shown in Figure 1. A description of each step is provided below.

Step 1 – New Sewer Availability Request Received by Planning Department

Typically, inquiries related to sewer service availability are first made with the Cookeville Planning Department. The Developer must submit a Sewer Availability Request that includes the location of the new development, the type and number of connections, estimated additional sewer flow with supporting calculations, and any other information necessary to evaluate the request for service. The estimated additional sewer flow is calculated in accordance with Section 2.5.1. The request for service and supporting document is sent to WQC by the Planning Department and is routed to the Lead Engineer for review. The status of the request is tracked in the GIS.

If this CAP applies to the new development as defined in Section 2.1, the evaluation proceeds to Step 2. If the CAP does not apply, the request is evaluated using normal WQC procedures.

Step 2 – Is the new connection upstream of a reoccurring overflow?

Once the request is received by WQC, GIS records are checked to determine if the proposed new service is upstream of a reoccurring overflow. If not, the review moves to Step 3. If so, the request is denied. If appropriate, WQC may discuss alternative approaches that would allow the development to proceed, such as discharging to a different basin.

Step 3 – Are any downstream segments surcharged during wet weather as defined in Section 3?

The GIS is checked to determine if there are any segments downstream of the proposed new service that are surcharged as previously defined. If not, the review moves to Step 4. If so, the request is denied.

Step 4 – Can the WWTP accommodate the additional peak flow?

The proposed flow from the new service is checked against the available WWTP wet weather capacity, and if the new flow is less than the available capacity, the review moves to Step 5. However, if the new service will consume more than 50% of the available treatment capacity, the Developer may be required to meet additional conditions, such as providing flow equalization or funding improvements to the WWTP. If the WWTP does not have sufficient capacity to accommodate the new flow and load, the request is denied.

Step 5 – Can the interceptor accommodate the additional one-hour peak flow?

The flow from the new service is compared to the available interceptor capacity, and if the interceptor has sufficient capacity, the review moves to Step 6. However, if the new service will consume more than 50% of the available capacity, the Developer may be required to meet additional conditions. If the interceptor does not have adequate available capacity to accommodate the new service, the request is denied.

Step 6 – Can the trunk sewer accommodate the additional one-hour peak flow?

The flow from the new service is compared to the available trunk sewer capacity, and if the trunk sewer has sufficient capacity, the review moves to Step 7. However, if the new service will consume more than 50% of the available capacity, the Developer may be required to meet additional conditions. If the trunk sewer does not have adequate available capacity to accommodate the new service, the request is denied.

Step 7 – Can the pump station accommodate the additional one-hour peak flow?

The flow from the new service is compared to the available pump station capacity, and if the pump station has sufficient capacity, the review moves to Step 8. However, if the new service will consume more than 50% of the available capacity, the Developer may be required to meet additional conditions. If the pump station does not have adequate available capacity to accommodate the new service, the request is denied.

Step 8 – Can the collector sewers accommodate the additional one-hour peak flow?

The flow from the new service is compared to the available collector sewer capacity, and if the collector sewer has sufficient capacity, the review moves to Step 9. However, if the new service will consume more than 50% of the available capacity, the Developer may be required to meet additional conditions. If the collector sewer does not have adequate available capacity to accommodate the new service, the request is denied.

Step 9 – Issue Service Commitment Letter

If the new service request meets all of the conditions outlined above, a Commitment Letter is issued for the new service. The Commitment Letter will contain the expiration date of the commitment, which is generally one year from the date of the Commitment Letter.

3.3 SPECIAL CONDITIONS

The City may authorize new service or an increase in service for certain types of facilities even when adequate capacity cannot be certified. Facilities that will be considered for special approval include health care facilities, public schools, and governments facilities. In addition, special approval may be granted for areas of failing septic systems. Capacity Credits will be used to offset Special Approvals when available.

Figure 1 – CAP Flow Chart



APPENDIX

City of Cookeville
Sewer Service Availability Request

Building Permit # _____

EMAIL TO: Matthew Phillips, PE (mdp@cookeville-tn.gov)

OR

MAIL TO: Matthew Phillips, PE
 City of Cookeville
 Department of Water Quality Control
 1860 South Jefferson Ave
 Cookeville, TN 38501

<p>Proposed Development Site:</p> <p>Street Address: _____</p> <p>Parcel Number for Primary Parcel: Control Map Group Parcel#</p> <div style="display: flex; justify-content: space-around; width: 100%;"> <div style="border: 1px solid black; width: 80px; height: 25px;"></div> <div style="border: 1px solid black; width: 80px; height: 25px;"></div> <div style="border: 1px solid black; width: 80px; height: 25px;"></div> </div> <p>Additional Parcel Numbers: _____</p> <p>Describe the proposed/current/prior land use and any existing structures, as well as proposed structures:</p>	<p style="text-align: center;">WQC Use Only</p> <p>Date Rec'd _____</p> <p>Processed by: _____</p> <p>Basin _____</p> <p>Prior Usage (gpd) _____</p> <p>Proposed (gpd) _____</p> <p>Change (gpd) _____</p> <p>Cap Available (gpd) _____</p> <p>Credits Used _____</p>
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<p>Proposed Development:</p> <p><input type="checkbox"/> Single Family Residence: # Residences: _____ gpd</p> <p><input type="checkbox"/> Condos/Townhomes: # 1-BR _____ # 2-BR _____ # 3-BR _____ # 4-BR _____ gpd</p> <p><input type="checkbox"/> Apartments: # 1-BR _____ # 2-BR _____ # 3-BR _____ # 4-BR _____ gpd</p> <p><input type="checkbox"/> Office Building: Finished Square Footage: _____ # Employees: _____ gpd</p> <p><input type="checkbox"/> Retail: Finished Square Footage: _____ # Employees: _____ gpd</p> <p><input type="checkbox"/> Warehouse: Square Footage of Finished Office Space: _____ # Employees including office: _____ gpd</p> <p><input type="checkbox"/> Restaurant/Food Service: # of Seats: _____ gpd</p> <p><input type="checkbox"/> School/Daycare: Elementary or Below _____ Middle School or Above _____ # Students: _____ gpd</p> <p><input type="checkbox"/> Doctor/Dental Care: # Doctors: _____ # Staff: _____ # Patients: _____ gpd</p> <p><input type="checkbox"/> Veterinary Clinic/Dog Kennel: # Staff: _____ # Runs: _____ # Cages _____ gpd</p> <p><input type="checkbox"/> Hospital: # Beds: _____ gpd</p> <p><input type="checkbox"/> Nursing Home/Assisted Living: # Patients: _____ # Residential Staff: _____ # Non-Residential Staff: _____ gpd</p> <p><input type="checkbox"/> Hotel/Motel: # Rooms: _____ gpd</p> <p><input type="checkbox"/> Church: # Sanctuary Seats: _____ Kitchen? <input type="checkbox"/> Yes <input type="checkbox"/> No _____ gpd</p> <p>Other (describe below – include square footage, occupancy, number of parking spaces, etc as applicable): _____ gpd</p> <p style="text-align: right;">Total Flow: _____ gpd</p>	<p style="text-align: center;">Est. Sewage Flow, gpd (WQC Use Only)</p>
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I certify that I am the (*check one*) owner developer engineer or architect representing the owner and that all information provided is true and accurate to the best of my knowledge.

Phone: _____ Signature: _____ Date: _____

Email: _____ Printed Name: _____

Company: _____

Mailing Address: _____

Sewer Service Availability expires one (1) year after the approval date (below) in accordance with the Capacity Assurance Program. After the approval date, a new request shall be submitted.

Approved by: _____

Date: _____

**NOAA Atlas 14, Volume 2, Version 3 COOKEVILLE
Station ID: 40-2009**



Location name: Cookeville, Tennessee, USA*
Latitude: 36.1075°, Longitude: -85.5033°



Elevation:
Elevation (station metadata): 1090 ft**

* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.381 (0.349-0.418)	0.450 (0.413-0.494)	0.528 (0.484-0.578)	0.595 (0.543-0.650)	0.684 (0.619-0.746)	0.754 (0.679-0.822)	0.829 (0.741-0.903)	0.905 (0.802-0.987)	1.01 (0.883-1.10)	1.10 (0.947-1.20)
10-min	0.609 (0.557-0.668)	0.720 (0.660-0.789)	0.846 (0.776-0.926)	0.952 (0.869-1.04)	1.09 (0.987-1.19)	1.20 (1.08-1.31)	1.32 (1.18-1.44)	1.44 (1.27-1.56)	1.60 (1.40-1.74)	1.73 (1.49-1.89)
15-min	0.761 (0.697-0.835)	0.905 (0.830-0.992)	1.07 (0.981-1.17)	1.20 (1.10-1.31)	1.38 (1.25-1.51)	1.52 (1.37-1.66)	1.67 (1.49-1.81)	1.81 (1.60-1.97)	2.01 (1.76-2.19)	2.17 (1.87-2.37)
30-min	1.04 (0.955-1.14)	1.25 (1.15-1.37)	1.52 (1.39-1.67)	1.74 (1.59-1.91)	2.05 (1.85-2.23)	2.29 (2.06-2.50)	2.55 (2.28-2.78)	2.82 (2.50-3.07)	3.20 (2.80-3.49)	3.51 (3.03-3.83)
60-min	1.30 (1.19-1.43)	1.57 (1.44-1.72)	1.95 (1.79-2.13)	2.27 (2.07-2.48)	2.72 (2.47-2.97)	3.10 (2.79-3.38)	3.51 (3.14-3.83)	3.95 (3.50-4.31)	4.59 (4.01-5.00)	5.12 (4.43-5.59)
2-hr	1.53 (1.40-1.68)	1.83 (1.68-2.02)	2.28 (2.08-2.51)	2.65 (2.40-2.91)	3.18 (2.87-3.49)	3.63 (3.25-3.98)	4.11 (3.65-4.50)	4.63 (4.08-5.07)	5.38 (4.67-5.90)	6.02 (5.16-6.60)
3-hr	1.67 (1.53-1.83)	2.00 (1.83-2.21)	2.47 (2.25-2.72)	2.86 (2.61-3.15)	3.43 (3.10-3.76)	3.90 (3.51-4.27)	4.41 (3.93-4.82)	4.96 (4.38-5.43)	5.75 (5.01-6.30)	6.41 (5.51-7.04)
6-hr	2.04 (1.87-2.25)	2.43 (2.23-2.69)	2.97 (2.71-3.28)	3.43 (3.12-3.78)	4.08 (3.69-4.49)	4.63 (4.16-5.09)	5.21 (4.64-5.72)	5.83 (5.15-6.40)	6.72 (5.85-7.38)	7.45 (6.41-8.19)
12-hr	2.48 (2.29-2.70)	2.95 (2.72-3.22)	3.59 (3.31-3.92)	4.13 (3.80-4.51)	4.89 (4.47-5.33)	5.52 (5.01-6.00)	6.18 (5.58-6.72)	6.88 (6.15-7.48)	7.87 (6.95-8.57)	8.68 (7.57-9.47)
24-hr	3.07 (2.88-3.28)	3.66 (3.45-3.92)	4.47 (4.20-4.78)	5.10 (4.78-5.45)	5.97 (5.59-6.37)	6.67 (6.22-7.10)	7.38 (6.86-7.86)	8.11 (7.50-8.63)	9.12 (8.38-9.69)	9.90 (9.05-10.5)
2-day	3.73 (3.51-3.97)	4.45 (4.19-4.75)	5.43 (5.11-5.79)	6.21 (5.84-6.62)	7.27 (6.82-7.75)	8.13 (7.59-8.66)	9.00 (8.38-9.59)	9.91 (9.18-10.6)	11.1 (10.3-11.9)	12.1 (11.1-12.9)
3-day	3.97 (3.73-4.22)	4.74 (4.47-5.06)	5.76 (5.42-6.14)	6.57 (6.17-6.99)	7.65 (7.17-8.14)	8.50 (7.95-9.04)	9.37 (8.72-9.96)	10.3 (9.51-10.9)	11.4 (10.6-12.2)	12.4 (11.3-13.2)
4-day	4.21 (3.96-4.48)	5.04 (4.74-5.37)	6.10 (5.74-6.50)	6.92 (6.50-7.36)	8.02 (7.52-8.52)	8.88 (8.30-9.42)	9.73 (9.07-10.3)	10.6 (9.84-11.2)	11.7 (10.8-12.5)	12.6 (11.6-13.4)
7-day	5.07 (4.77-5.39)	6.05 (5.69-6.44)	7.28 (6.85-7.74)	8.23 (7.73-8.74)	9.47 (8.89-10.1)	10.4 (9.77-11.1)	11.4 (10.6-12.1)	12.4 (11.5-13.1)	13.7 (12.6-14.5)	14.6 (13.5-15.6)
10-day	5.78 (5.45-6.13)	6.86 (6.48-7.29)	8.19 (7.73-8.69)	9.21 (8.68-9.77)	10.6 (9.94-11.2)	11.6 (10.9-12.3)	12.6 (11.8-13.4)	13.6 (12.7-14.5)	15.0 (13.9-15.9)	16.0 (14.8-17.0)
20-day	7.94 (7.52-8.38)	9.38 (8.89-9.90)	10.9 (10.4-11.5)	12.1 (11.4-12.7)	13.5 (12.8-14.3)	14.6 (13.8-15.4)	15.6 (14.7-16.4)	16.6 (15.6-17.5)	17.7 (16.6-18.7)	18.6 (17.4-19.6)
30-day	9.79 (9.34-10.3)	11.5 (11.0-12.1)	13.2 (12.6-13.9)	14.5 (13.8-15.2)	16.1 (15.3-16.9)	17.2 (16.4-18.1)	18.3 (17.4-19.2)	19.3 (18.3-20.3)	20.5 (19.4-21.6)	21.4 (20.2-22.5)
45-day	12.4 (11.9-13.0)	14.5 (13.9-15.2)	16.6 (15.8-17.3)	18.0 (17.2-18.9)	19.9 (18.9-20.8)	21.2 (20.2-22.2)	22.4 (21.3-23.5)	23.5 (22.3-24.6)	24.9 (23.6-26.1)	25.8 (24.4-27.1)
60-day	14.9 (14.3-15.6)	17.5 (16.7-18.3)	19.8 (19.0-20.8)	21.5 (20.6-22.5)	23.6 (22.5-24.7)	25.0 (23.9-26.2)	26.4 (25.1-27.6)	27.6 (26.2-28.9)	29.0 (27.5-30.4)	30.0 (28.4-31.5)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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FLOW CALCULATIONS

For new Residential connections, the annual average flow contribution is calculated based on the flow per capita per the *Recommended Standards for Wastewater Facilities* (Ten State Standards), latest edition. This document can be found at <http://10statesstandards.com/wastewaterstandards.pdf>.

For Commercial, Industrial and Institutional flows, the annual average flow contribution is calculated using the latest edition of the TDEC *Design Criteria for Sewage Works* or acceptable calculations from the proposed facility's engineer. The TDEC flow information can be found at https://www.tn.gov/assets/entities/environment/attachments/wr-wq_pub_design-criteria-complete.pdf and is reproduced here for convenience.

Table 2-A.1. Typical Wastewater Flow Rates from Commercial Sources
(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day	
		Range	Typical
Airport	Passenger	2 - 4	3
Apartment House	Person	40 - 80	50
Automobile Service Station	Vehicle served	8 - 15	12
	Employee	9 - 15	13
Bar	Customer	1 - 5	3
	Employee	10 - 16	13
Boarding House	Person	25 - 60	40
Department Store	Toilet Room	400 - 600	500
	Employee	8 - 15	10
Hotel	Guest	40 - 60	50
	Employee	8 - 13	10
Industrial Building (Sanitary waste only)	Employee	7 - 16	13
Laundry (self-service)	Machine	450 - 650	550
	Wash	45 - 55	50
Office	Employee	7 - 16	13
Public Lavatory	User	3 - 6	5
Restaurant (with toilet)	Meal	2 - 4	3
	Conventional	Customer	8 - 10
	Short order	Customer	3 - 8
	Bar/cocktail lounge	Customer	2 - 4
Shopping Center	Employee	7 - 13	10
	Parking Space	1 - 3	2
Theater	Seat	2 - 4	3

Table 2-A.2. Typical Wastewater Flow Rates from Institutional Sources
(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day	
		Range	Typical
Assembly Hall	Seat	2 - 4	3
Hospital, Medical	Bed	125 - 240	165
	Employee	5 - 15	10
Hospital, Mental	Bed	75 - 140	100
	Employee	5 - 15	10
Prison	Inmate	80 - 150	120
	Employee	5 - 15	10
Rest Home	Resident	50 - 120	90
	Employee	5 - 15	10
School, day-only:			
With cafeteria, gym, showers	Student	15 - 30	25
With cafeteria only	Student	10 - 20	15
Without cafeteria, gym, or showers	Student	5 - 17	11
School, boarding	Student	50 - 100	75

Table 2-A.3. Typical Wastewater Flow Rates from Commercial Sources
(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day	
		Range	Typical
Apartment, resort	Person	50 - 70	60
Bowling Alley	Alley	150 - 250	200
Cabin, resort	Person	8 - 50	40
Cafeteria	Customer	1 - 3	2
	Employee	8 - 12	10
Camps:			
Pioneer Type	Person	15 - 30	25
Children's, with central toilet/bath	Person	35 - 50	45
Day, with meals	Person	10 - 20	15
Day, without meals	Person	10 - 15	13
Luxury, private bath	Person	75 - 100	90
Trailer Camp	Person	75 - 125	125
Campground-developed	Person	20 - 40	30
Cocktail Lounge	Seat	12 - 25	20
Coffee Shop	Customer	4 - 8	6
	Employee	8 - 12	10
Country Club	Guests on-site	60 - 130	100
	Employee	10 - 15	13
Dining Hall	Meal Served	4 - 10	7
Dormitory/bunkhouse	Person	20 - 50	40
Fairground	Visitor	1 - 2	2
Hotel, resort	Person	40 - 60	50
Picnic park, flush toilets	Visitor	5 - 10	8
Store, resort	Customer	1 - 4	3
	Employee	8 - 12	10
Swimming Pool	Customer	5 - 12	10
	Employee	8 - 12	10
Theater	Seat	2 - 4	3
Visitor Center	Visitor	4 - 8	5

PERSONS PER HOUSEHOLD

Persons per household taken from US Census Data posted at <http://www.cookeville-tn.gov/planning/plans-and-reports/cookeville-demographics/>.

INFILTRATION AND INFLOW REDUCTION DUE TO MANHOLE REHABILITATION

Infiltration and inflow reductions due to manhole rehabilitation are taken from *Manhole Inspection and Rehabilitation – MOP 92*, ASCE, and reproduced here.

Component		No I/I	Minor I/I (Weeper)	Moderate I/I (Dripper)	Heavy I/I (Runner)	Severe I/I (Gusher)
Cover	Description	no evidence	pick holes or other unsealed cover	corroded bearing surface	ponding <1" with pick holes or other unsealed cover	ponding >2" pick holes or other unsealed covers
	Flow Rate (gpm)	calculate	calculate	calculate	calculate	calculate
Frame Seal	Description	no evidence	water marks	some soil present at cracks	heavy soil or roots, 1/8" gap in drainage area	>1/8" gap in drainage area
	Flow Rate (gpm)	0	0.1	0.4	0.8	1.6 +
Chimney	Description	no evidence	water marks in 1 location	water marks at 2-3 locations or mineral deposits	multiple water marks, mineral deposits, joint leaks <25%	multiple water marks, mineral deposits, large drainage area, joints leaks >25%
	Flow Rate (gpm)	0	0.1	0.4	0.8	1.6 +
Corbel or Cone	Description	no evidence	water marks at 1-2 locations	water marks at 3-4 locations or mineral deposits, joint leak up to 10%	multiple water marks or mineral deposits, joint leaks up to 25%	multiple water marks, mineral deposits or soil present, joint leaks >25%
	Flow Rate (gpm)	0	0.2	0.4	0.8	1.6 +

Component		No I/I	Minor I/I (Weeper)	Moderate I/I (Dripper)	Heavy I/I (Runner)	Severe I/I (Gusher)
Wall	Description	no evidence	water marks at 1-2 locations	water marks at 3-4 locations or mineral deposits, joint leak up to 10%	multiple water marks or mineral deposits, joint leaks up to 25%	multiple water marks, mineral deposits or soil present, joint leaks >25%
	Flow Rate (gpm)	0	0.1	0.2	0.4	0.8 +
Pipe Seal	Description	no evidence	water marks at 1-2 locations	water marks at 3-4 locations or mineral deposits, seal leak up to 10%	multiple water marks or mineral deposits, seal leaks up to 25%	multiple water marks, mineral deposits or soil present, seal leaks >25%
	Flow Rate (gpm)	0	0.1	0.2	0.4	0.8 +
Bench	Description	no evidence	water marks at 1-2 locations	water marks at 3-4 locations or mineral deposits, joint leak up to 10%	multiple water marks or mineral deposits, joint leaks up to 25%	multiple water marks, mineral deposits or soil present, joint leaks >25%
	Flow Rate (gpm)	0	0.1	0.2	0.4	0.8 +
Invert or Channel	Description	no evidence	water marks, hairline cracks beneath flow	water marks, mineral deposits or 1/16" crack beneath flow	water marks and mineral deposits, 1/8" crack beneath flow	mineral deposits, soil, 1/4" crack beneath flow
	Flow Rate (gpm)	0	0.1	0.2	0.4	0.8 +