# APPENDIX Q2

## SSO Response SOP

| Revision History | | | |
|---|---|---|---|
| **Revision** | **Date** | **Approval** | **Reason** |
| 0 | 12/16/09 | J. Gonzalez | Original |
| | 09/26/19 | Jms. Cabral | • Reviewed – no changes |
| | 09/26/22 | Jms Cabral | • Reviewed – no changes |
| 1 | 07/19/23 | D. Stokes | • Reviewed – made changes according to 2022 SSS WDR Order. |
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|---|---|---|
| COL-SOP-50-001 | Sanitary Sewer Overflow Response | |
| Standard Operating Procedure (SOP) | Collections | Date: 10/26/2020 |
| Area – Collections System | Location: OCSD Service Area | |
| Orange County Sanitation District | Approved By:<br>Don Stokes<br>Collections Manager<br>Stokes, Don<br>Digitally signed by Stokes, Don<br>DN: dc=com, dc=insideocsd, ou=OCSDEndUserSupport, ou=All Users, ou=OCSDUsers, ou=O&M, ou=820 - Collection Facilities, cn=Stokes, Don, email=DStokes@OCSD.COM<br>Date: 2020.10.26 13:21:24 -07'00' | |

**Task Description:** Responding to a Sanitary Sewer Overflow (SSO)

**C - A - U - T - I - O - N**

The SOP is subject to variations dependent on conditions and maintenance that may be occurring. Staff are encouraged to exercise judgement within the duty of care expectation. If you have questions or concerns consult with Supervision.

## Overview

*This SOP details the tasks performed in response to a sanitary sewer overflow. The response is designed to protect the public's health and safety, minimize the impact to the environment, and satisfy all regulatory agency reporting and the Waste Discharge Requirement (WDR).*

### Safety & Other Precautions

- Notify Control Center upon arrival.
- Traffic Control (cones, delineators, arrow board, etc.)
- Personal Protective Equipment (PPE)
- Direct Reading Air Monitoring Equipment (Max XT II)
- Slip and Fall Danger (especially when working with sewage over bare soil surfaces, slopes and around water ways)
- Open Manhole Hazards
- Site Control

### Tools & Equipment Needed

- Hand Tools
- Traffic Control Equipment
- Air Monitoring Equipment
- Handheld Radios
- Personal Protective Equipment (PPE)
- Spill Containment Materials (rubber mats, absorbent pillows, booms, etc.)
- Debris Catching Equipment (Rake)
- Camera
- Cleaning Materials (Broom, Shovel, Hoses, etc.)
- Notebook
- Combination Sewer Cleaning Truck (combo truck)
- Trunk Sewer Atlas - GIS
- Field SSO Report Form

## Step 1: Notification & Mobilization

1. Upon receipt of a call from the Control Center, the supervisor will assign/dispatch a response team.
    a. If the SSO is reported after normal business hours, the Control Center will contact the standby persons to respond.
2. Prior to the start of work, conduct a tailgate safety meeting to discuss safety precautions, review procedures, and assign responsibilities to each person on the crew.
3. Prior to mobilizing to the spill, identify the spill location on the Trunk Sewer Atlas to collect preliminary information. This information includes:
    a. OCSD lines in the vicinity
    b. OCSD line size(s)
    c. Direction the sewer line is flowing
    d. Distance between manholes
    e. Location of Diversion Structures
    f. Local storm drain entry points and path of travel
4. Select a vehicle and equipment appropriate for the spill location, typically a combination sewer cleaning truck (combo truck).

**NOTE:** The line size located on the map will help determine the resources needed to respond to the spill.

## Step 2: SSO Location Set-Up

1. Upon arrival at the spill location, the first responders typically perform multiple tasks within a relatively short amount of time. These tasks are listed below and described in further detail below and summarized in Attachment A: OCSD SSO Response Flowchart.
   a. *Communication with Control Center.* The field personnel are to maintain communication with the Control Center to establish a timeline needed for reporting purposes. The key information that needs to be communicated are:
      i. arrival time;
      ii. estimated spill volume;
      iii. time spill containment was set;
      iv. time the blockage was relieved; and
      v. time the containment was removed.
   b. *Spill Verification and Source Determination.* The field personnel are to determine whether the spill is a sewer spill or other type of spill. To determine the source of the spill, follow the path of the spill on the surface. Notify the Plant Control Center and your supervisor so that an effort can be made to stop the flow of the spill.
   c. *Communication with Supervisor.* The field personnel are to maintain communication with a supervisor during work hours. The supervisor assigned is typically the person who dispatched the crew to the spill. Field personnel are to relay pertinent information to the Supervisor who will assign additional resources, such as additional personnel, equipment, and/or the involvement of other agencies .

**NOTE:** If the spill occurs after hours, communicate directly with the Control Center.

## Step 3: Spill Containment

1. *Traffic Control.* If the spill is located in an area where traffic control is needed, all traffic control setups should be consistent with the "Work Area Traffic Control Handbook (W.A.T.C.H.)" (Figure 1).
2. *Public Safety.* If additional resources are needed to manage or control the public safety, contact the Supervisor or Control Center and they will notify the appropriate agencies. Otherwise divert the traffic out of SSO area.

Figure 1: Traffic Control, Lane Closure (typical)

3. *Spill Source Determination and Containment.* Determine the source of the sewer spill (OCSD, City, or private lateral) and relay that information to the Supervisor (Figure 2). If the spill is not an OCSD sewer spill, continue with spill containment procedures until the responsible party or agency arrives. OCSD will continue support, as needed.


Figure 2: Overflowing Manhole (example)

   a) If the spill occurs after hours, communicate the spill source information to the Control Center

   Containment materials are to be set up in strategic locations to control and contain the spilled wastewater. These materials include: rubber mats, sand bags, absorbent materials (socks, pillows, broom), soil, or any materials located near the spill that can aid in spill containment. The containment materials should be set up to block the spill from entering (or continuing to enter) storm drains or other waterways (Figure 3). If possible, spills should be diverted to natural low areas where the materials can collect prior to removal.


Figure 3: Spill Containment Set-Up (example)

   When placing the rubber mat, smooth the surface to prevent flow from moving under. Secure the mat in place with buckets of sand, sandbags, dirt, or other heavy objects to keep it in place.

Once the spill is contained and the flow is "ponding," collect depth measurements to help estimate the volume of material involved in the spill.

Use absorbent booms or sand/dirt to build dams to reduce flow velocity when the spill is flowing downhill.

As possible, divert flow to a downstream manhole to return the sewage flow back into the system. This may by using sandbags or dirt channels to direct the flow.

4. *Clean Up.* Use an industrial combination sewer cleaning vehicle to remove the ponded material and any used wash down water (Figure 4). Keep the drain entrance covered as long as sewage material is present.

Figure 4: Overflow Clean Up Using Industrial Combination Sewer Cleaning Vehicle (typical)

## Step 4: Spill Volume Estimation

Document all assumptions made to get to an estimated volume. Use at least two methods to make the estimate. Take photos and video to document the situation and provide support for the given estimate.

1. Eyeball Estimation: Make a determination based on experience. Use for initial estimation only, use secondary estimation method for documentation.
2. Secondary Estimation: Use the "Sewer Spill Estimation Guide" (Attachment C) issued by the Orange County Area Waste Discharge Requirements Steering Committee. Approach examples are noted as follows:
   a. Pick & Vent Holes in Manholes: Spill Volume Approximation Worksheet: Measure the height of the water exiting the vent holes or pick holes. Once the measurement is obtained, match the vent hole size and wastewater height on the and provide the Control Center with a preliminary spill volume assessment (small, medium, large). A copy of the Spill Volume Approximation Worksheet is included as Attachment B.
   b. Counting Connections: Duration x Flow Rate = Spill Volume. Good for spills affecting a small portion of the collection system; must have reliable volume per household. Can be difficult to apply to areas with mixed use (residential, commercial, industrial).
   c. Measured Volume: Area/Volume: Size of the "Wetted Footprint" + Amount Captured/Contained, see Figure 3. 1. Area of a Right Triangle in Cubic Feet: Length x Width x 0.05 x Depth
   d. Area of a Circle in Cubic Feed: Diameter Squared x 0.785 x Depth
   e. Overflow Picture Chart: Reference photos
   f. Lift/Pump Station Estimation: Use metered data to determine spill volume.
   g. Spill Simulator Determine the volume of a spill by increasing the volume (flow) on the simulator until it best resembles the actual flow.
   h. Portable Flow Monitoring Equipment: Install the flow monitoring equipment in the same mainline segment that experience the spill after the event has concluded. Monitor for the same time (period/duration). Use the Average Flow Rate and apply it to the spill.

## Step 5: Field Documentation

1. *Notes.* At a minimum, the field notes should include arrival time, time spill containment was set, time the blockage was relieved, departure time, and all persons and equipment mobilized to the scene. In addition, document any officials (law enforcement, health department, etc.) who are present. If any official gives direct orders that stray from the OCSD spill response procedures, document that person's information (name, badge number, phone number) and notify the OCSD supervisor; if the spill occurs after hours, relay the pertinent information to the Control Center.

2. *Sketch.* The field sketch should document the path of the flow, the height of the water coming from the manhole cover vent holes, the location of the sewage, storm drains, waterways, and the manhole or structure ID numbers ( Figure 5).

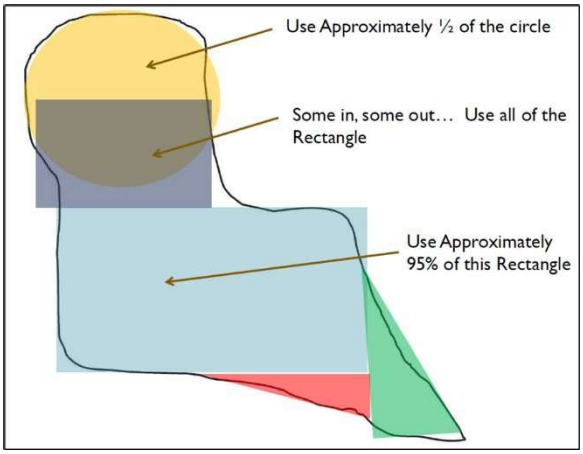


Figure 5: Sketch of Spill Area (typical)

3. *Photographs.* Photographs (preferably digital) should be taken of the spill area, spill containment measures, scene after cleanup, and any other information deemed pertinent (**Error! Reference source not found.**).


Figure 6: Spill Area Documentation Photo (typical)

## Step 6: Blockage Location Determination & Clearing

1. Field personnel are to determine the location of the blockage. The blockage location is determined by opening manhole covers downstream of the spill location to look for surcharge.
    - **Prior to opening the manholes (OCSD or City), check for explosive or toxic gasses using a direct-reading air monitoring device by inserting tubing into the pick-holes. If explosive gases are present, DO NOT LIFT OR REMOVE the cover.**
2. Start by opening the first manhole downstream of the spill. If surcharge is observed, move to the next downstream manhole. When no surcharge is observed in a manhole, the blockage is located somewhere between that manhole and the spill location.
3. Once the blockage location has been determined, set up the combo truck on the first downstream manhole that was not surcharged.
4. Place one crew member on the downstream side of the combo truck with a rake or other device designed to catch the blockage.
5. Personnel at the combo truck are to run the penetrating nozzle upstream to relieve the blockage.
6. The crew member staged on the downstream side of the combo truck is to catch the blockage with debris catching equipment (i.e., rake). This minimizes the amount of blockage material traveling through the line to minimize future blockages. Identify blockage material to determine the cause of the obstruction and potential follow-up activities necessary (Figure 7).

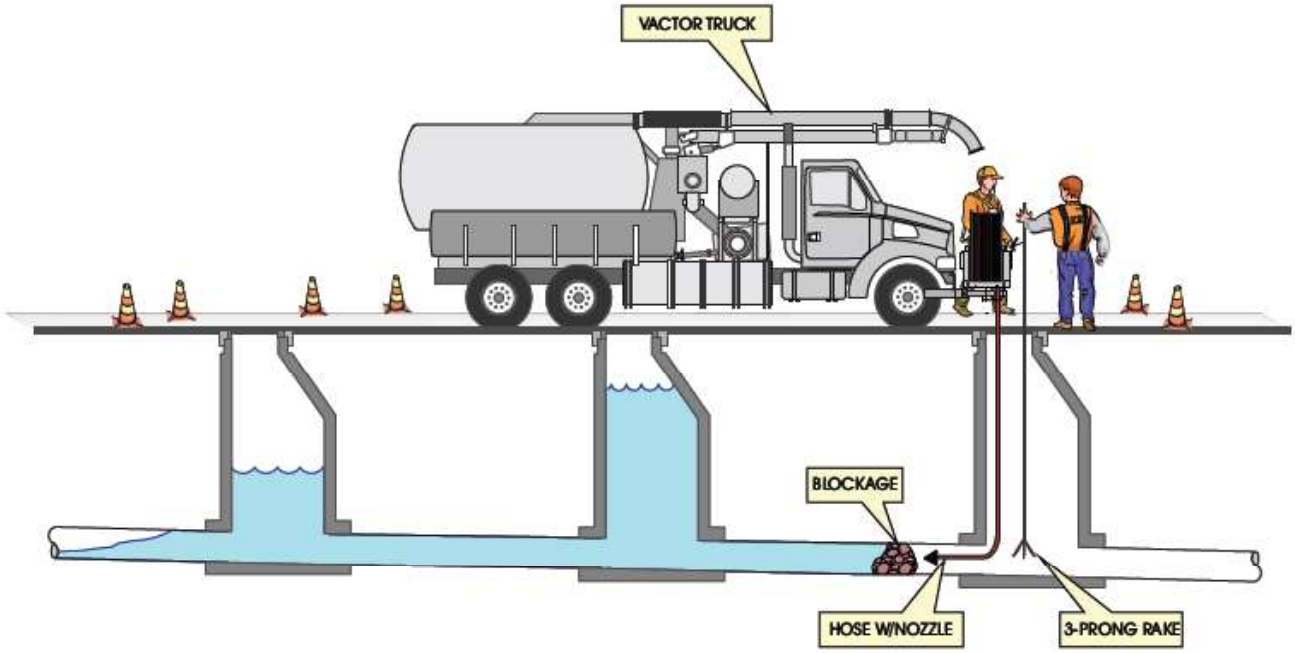



Figure 7: Clearing a Blockage Diagram

7. Once the blockage is cleared, document the time and relay the information to the Control Center as soon as possible. This information is extremely important in the final calculations used to determine the volume spilled.
    - If a blockage can't be relieved within a reasonable amount of time, contact the supervisor and/or Control Center to discuss response options (i.e., additional staff and equipment) or use of upstream diversion structures. It is important to contact the Control Center prior to diversion structure implementation to verify that potentially affected parties are notified.
8. Determine the further follow-up actions needed for the blockage area (i.e., root cutting if roots are collected on the rake, line cleaning if grease is observed, etc.). Follow-up procedures can include line cleaning, root cutting, line repairs, and CCTV.
9. Assess the flow in the line to verify that the blockage has not migrated to a downstream segment.
    - **Prior to opening the manholes (OCSD or City), check for explosive or toxic gasses using a direct-reading air monitoring device by inserting tubing into the pick-holes. If explosive gases are present, DO NOT LIFT OR REMOVE the cover.**
10. If conditions are acceptable, open several downstream manholes and look for surcharge in downstream manholes. If no surcharge is present, the line segment is determined to be clear.

## Step 7: Site Clean-Up

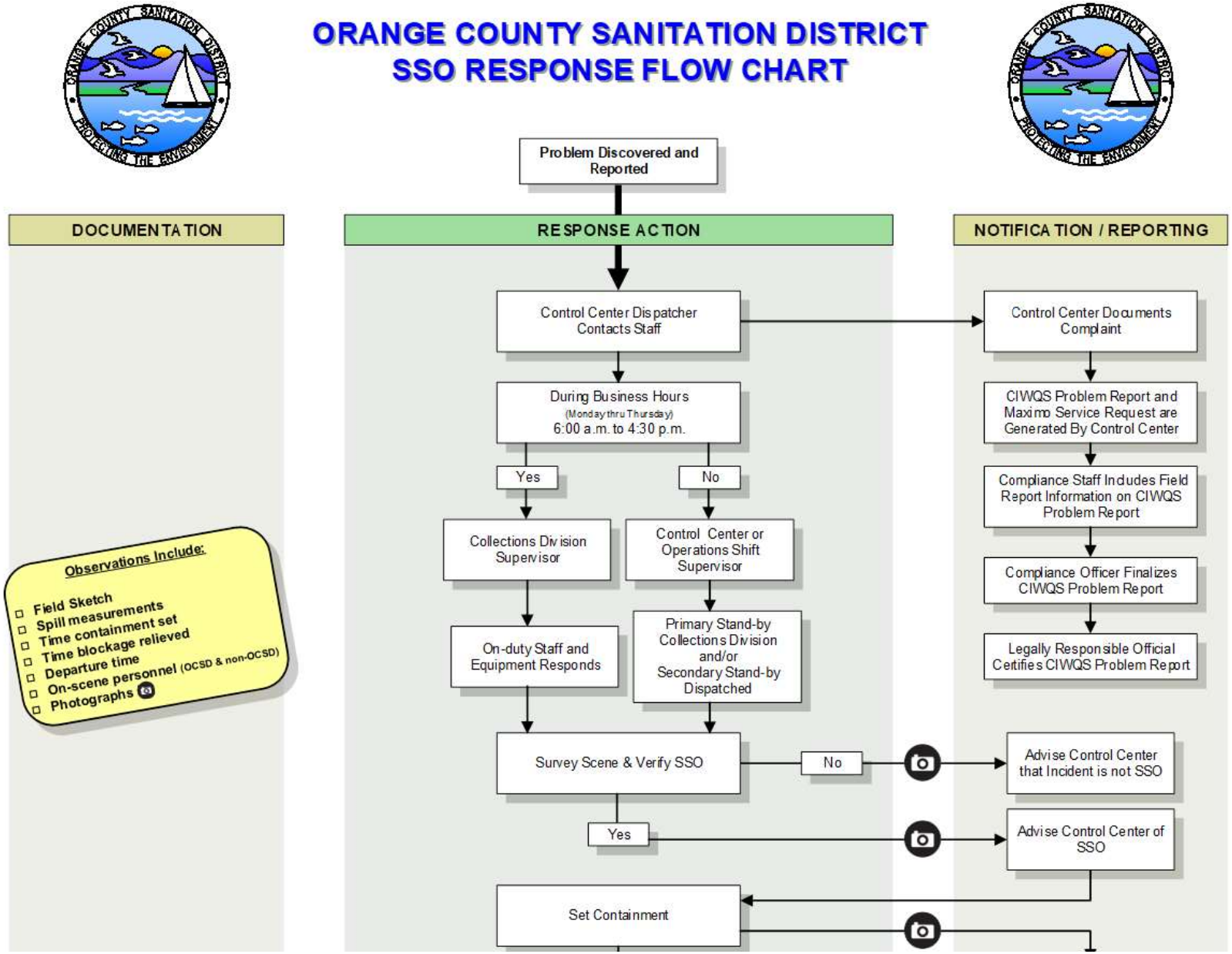
1. Once the blockage is cleared and the threat for additional related spills is relieved, use a combo truck to vacuum the wastewater that collected in the containment areas.
2. Wash down all areas covered by the spill, being sure to capture the wastewater.
3. Remove spill containment materials.
4. Return the wastewater to the OCSD sewer system.
5. Notify the Control Center that the cleanup is complete.

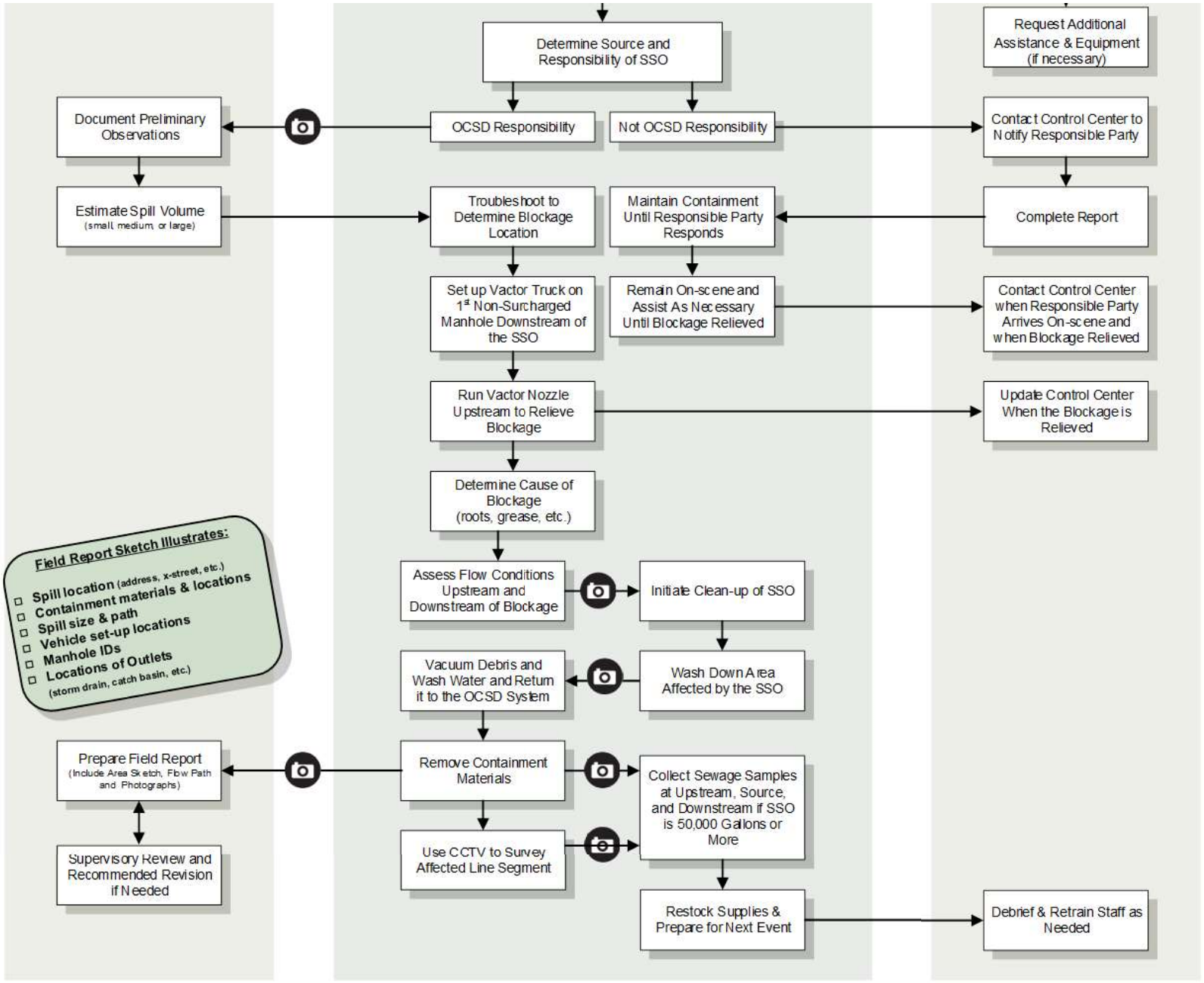
Figure 8: Site Cleanup Documentation (typical)

## Step 8: SSO Response Wrap-Up

1. Demobilize field response.
2. Complete the Collection System Problem Report – Field SSO Report form. A copy of the Field Report Form is presented in Attachment C.
3. Restock the vehicle of materials used to contain and clean the spill.
4. Document all activities/tasks in Maximo work order:
    a. Attach photos
    b. Attach field SSO report
    c. Create appropriate log
5. Return the completed Spill Report to the Supervisor. The Supervisor will review and initial the report and distribute it to the appropriate OCSD personnel.

Attachment A: OCSD SSO Response Flowchart




Determine Source and Responsibility of SSO
Request Additional Assistance & Equipment (if necessary)
Document Preliminary Observations
OCSD Responsibility
Not OCSD Responsibility
Contact Control Center to Notify Responsible Party
Estimate Spill Volume (small, medium, or large)
Troubleshoot to Determine Blockage Location
Maintain Containment Until Responsible Party Responds
Complete Report
Set up Vactor Truck on 1st Non-Surcharged Manhole Downstream of the SSO
Remain On-scene and Assist As Necessary Until Blockage Relieved
Contact Control Center when Responsible Party Arrives On-scene and when Blockage Relieved
Run Vactor Nozzle Upstream to Relieve Blockage
Update Control Center When the Blockage is Relieved
Determine Cause of Blockage (roots, grease, etc.)
Field Report Sketch Illustrates:
Spill location (address, x-street, etc.)
Containment materials & locations
Spill size & path
Vehicle set-up locations
Manhole IDs
Locations of Outlets (storm drain, catch basin, etc.)
Assess Flow Conditions Upstream and Downstream of Blockage
Initiate Clean-up of SSO
Vacuum Debris and Wash Water and Return it to the OCSD System
Wash Down Area Affected by the SSO
Prepare Field Report (Include Area Sketch, Flow Path and Photographs)
Remove Containment Materials
Collect Sewage Samples at Upstream, Source, and Downstream if SSO is 50,000 Gallons or More
Supervisory Review and Recommended Revision if Needed
Use CCTV to Survey Affected Line Segment
Restock Supplies & Prepare for Next Event
Debrief & Retrain Staff as Needed

## Attachment B: Spill Volume Estimation Worksheet

**Orange County Sanitation District**
**COLLECTION SYSTEM PROBLEM REPORT – FIELD SSO REPORT – OCSD SPILLS**
***Original to Collections Supervisor***

Collections Notified By: _____ Date: _____ Time: _____

CMMS Work Order #: _____ -or- SSO Event ID #: _____

Estimated spill size: ☐ Small *(1-1,000gal)* ☐ Medium *(1,001-10,000 gal)* ☐ Large *(> 10,000gal)*

Spill Address (location) _____

Is spill: Local ☐ Regional ☐ _____ ***(Use Unincorporated County if applicable)***

Is this an Area 7 spill? (i.e., in, from, or caused by District's facilities?) Yes ☐ No ☐

When you arrived onsite was there a Wet Spot ☐ or Flowing Sewage ☐

*Did any eyewitnesses indicate when the SSO could have started?* Yes ☐ No ☐ If yes, date / time they first noticed SSO? _____ /

**2) ESTIMATE SPILL VOLUMES**

**a)** Estimated spill volume that reached a separate storm drain? _____ gal

**b)** Estimated spill volume recovered from the separate storm drain? (*Do not include water used for clean-up)* _____ gal

**c)** Estimated spill volume that reached a drainage channel? *(i.e. flood control channel)* _____ gal

**d)** Estimated spill volume recovered from a drainage channel? *(i.e. flood control channel)* _____ gal

**e)** Estimated spill volume discharged directly to a surface water body? *(i.e. river, ocean bay)* _____ gal

**f)** Estimated spill volume recovered from surface water body? *(i.e. river, ocean bay)* _____ gal

**g)** Estimated spill volume discharged to a land? _____ gal

**h)** Estimated spill volume recovered from a discharge to land? *(Do not include water used for clean-up)* _____ gal

**3)** Did the spill discharge to a drainage channel and/or other surface? Yes ☐ No ☐

**4)** Did the spill reach a storm drainpipe hat is not part of a combined sewer system? Yes ☐ No ☐

**5)** If spill reached a separate storm drainpipe, was all of the wastewater fully captured from the separate storm drain and returned to the sanitary sewer system? Yes ☐ No ☐

**PHYSICAL LOCATION DETAILS**

**6)** Spill location name: _____

**7)** GPS Latitude *(e.g 33.70218)* _____ **(8)** GPS Longitude *(e.g 117.85461)* _____

**11)** Spill location description: _____

**Orange County Sanitation District**
**COLLECTION SYSTEM PROBLEM REPORT – FIELD SSO REPORT – OCSD SPILLS**
***Original to Collections Supervisor***

## SPILL DETAILS

**12)** Number of appearance points: _____

**13)** Spill appearance point: _____

**15)** Final spill destination: _____

**17)** Estimated spill start date/time: _____ / _____

**18)** Date and time sanitary sewer system agency was notified of or discovered spill: _____ / _____

**19)** Estimated Operator arrival date/time: _____ / _____ Time containment set: _____

**20)** Estimated spill end date/time: _____ / _____ Time clean up completed/left site: _____

**21)** Spill cause: Grease ☐ Debris-general ☐ Debris-rags ☐ Debris-Construction ☐ Root intrusion ☐
Vandalism ☐ Upper lateral (public) ☐ Lower lateral (public) ☐
Pump Station failure: Controls ☐ Mechanical ☐ Power ☐ Pipe structural problem/ failure ☐

**22)** Spill Cause explanation *(if other)* _____

**23)** Where did failure occur? Gravity Main ☐ Upper lateral (public) ☐ Manhole ☐
Force Main ☐ Lower lateral (public) ☐ Siphon ☐
Pump Station failure: Controls ☐ Mechanical ☐ Power ☐

**24)** Explanation of failure *(if other)*: _____

**25)** Was this spill associated with a storm event? Yes ☐ No ☐

**26)** Diameter of sewer pipe at the point of blockage or failure: _____ **in.**

**27)** Material of sewer pipe at the point of blockage or failure *(w/blockage – PVC, CIP, DIP, etc.):* _____

**28)** Estimated age of sewer asset at the point of blockage or failure: _____

**29)** Spill response activities: Cleaned up ☐ Mitigated effects of spill ☐ Contained all or portion of spill ☐ Restored flow ☐
Returned all or portion of spill to sanitary sewer ☐ Other ☐

**44)** Explanation of spill response activities (***action taken***): _____

_____

_____

_____

Estimated current spill rate *(if applicable):* _____ **gallons per minute**

Number of holes: _____ Size of holes: _____ Height of flow: _____

Estimate the sewage **path**: Depth *(if flowing)*: _____ Width: _____ Length: _____

Velocity (*ft/sec*): _____ Other Info: _____

Estimated volume of wash down water used? _____ gal Was 100% of this wash water and all sewage-contaminated water recovered? Yes ☐ No ☐

Contract #: _____ Manhole/Station # I.D.: _____

Containment material(s) used: _____

Responding Personnel: _____

Did any other agencies respond to or assist with the spill? Yes ☐ No ☐

If yes, list the name of the agencies and describe their action.

_____

_____

**FOLLOW-UP:**

Is this an existing high frequency location? Yes ☐ No ☐ Should it be added to the list? Yes ☐ No ☐

Has there been another SSO within **1,000 feet** of this location in the last 12-months (*by pipe segments or by radius*)? Yes ☐ No ☐ If yes, please list dates: _____

Describe recommended follow-up work. _____

_____

Collections Staff Signature: _____ Date: _____

## Attachment C: Spill Calculations (Gravity) Vent Hole

| Dia | Area | Water Ht | Water Ht | Time | velocity | Q | Q | Q |
|---|---|---|---|---|---|---|---|---|
| inches | Ft2 | inches | inches | sec | fps | cfs | gpm | gph |
| | | | | | | | | |
| **Vent Hole** | | | | | | | | |
| 0.50 | 0.0014 | 1/8 | 0.13 | 0.0254 | 0.8187 | 0.0011 | 0.50 | 30 |
| 0.50 | 0.0014 | 1/16 | 0.06 | 0.0180 | 0.5789 | 0.0008 | 0.35 | 21 |
| 0.50 | 0.0014 | 1/32 | 0.03 | 0.0127 | 0.4093 | 0.0006 | 0.25 | 15 |
| 0.50 | 0.0014 | 1/64 | 0.02 | 0.0090 | 0.2894 | 0.0004 | 0.18 | 11 |
| 0.50 | 0.0014 | 1/16 | 0.06 | 0.0180 | 0.5789 | 0.0008 | 0.35 | 21 |
| 0.50 | 0.0014 | 1/8 | 0.13 | 0.0254 | 0.8187 | 0.0011 | 0.50 | 30 |
| 0.50 | 0.0014 | 1/4 | 0.25 | 0.0360 | 1.1578 | 0.0016 | 0.71 | 43 |
| 0.50 | 0.0014 | 1/2 | 0.50 | 0.0509 | 1.6373 | 0.0022 | 1.00 | 60 |
| 0.50 | 0.0014 | 3/4 | 0.75 | 0.0623 | 2.0053 | 0.0027 | 1.23 | 74 |
| 0.50 | 0.0014 | 1 | 1.00 | 0.0720 | 2.3155 | 0.0032 | 1.42 | 85 |
| 0.50 | 0.0014 | 1 1/4 | 1.25 | 0.0805 | 2.5888 | 0.0035 | 1.58 | 95 |
| 0.50 | 0.0014 | 1 1/2 | 1.50 | 0.0882 | 2.8359 | 0.0039 | 1.74 | 104 |
| 0.50 | 0.0014 | 1 3/4 | 1.75 | 0.0952 | 3.0632 | 0.0042 | 1.87 | 112 |
| 0.50 | 0.0014 | 2 | 2.00 | 0.1018 | 3.2747 | 0.0045 | 2.00 | 120 |
| 0.50 | 0.0014 | 2 1/4 | 2.25 | 0.1080 | 3.4733 | 0.0047 | 2.13 | 128 |
| 0.50 | 0.0014 | 2 1/2 | 2.50 | 0.1138 | 3.6612 | 0.0050 | 2.24 | 134 |
| 0.50 | 0.0014 | 2 3/4 | 2.75 | 0.1194 | 3.8399 | 0.0052 | 2.35 | 141 |
| 0.50 | 0.0014 | 3 | 3.00 | 0.1247 | 4.0106 | 0.0055 | 2.45 | 147 |
| 0.50 | 0.0014 | 3 1/4 | 3.25 | 0.1298 | 4.1744 | 0.0057 | 2.55 | 153 |
| 0.50 | 0.0014 | 3 1/2 | 3.50 | 0.1347 | 4.3320 | 0.0059 | 2.65 | 159 |
| 0.50 | 0.0014 | 3 3/4 | 3.75 | 0.1394 | 4.4840 | 0.0061 | 2.74 | 165 |
| 0.50 | 0.0014 | 4 | 4.00 | 0.1440 | 4.6311 | 0.0063 | 2.83 | 170 |
| 0.50 | 0.0014 | 4 1/4 | 4.25 | 0.1484 | 4.7736 | 0.0065 | 2.92 | 175 |
| 0.50 | 0.0014 | 4 1/2 | 4.50 | 0.1527 | 4.9120 | 0.0067 | 3.01 | 180 |
| 0.50 | 0.0014 | 4 3/4 | 4.75 | 0.1569 | 5.0466 | 0.0069 | 3.09 | 185 |
| 0.50 | 0.0014 | 5 | 5.00 | 0.1609 | 5.1777 | 0.0071 | 3.17 | 190 |
| 0.50 | 0.0014 | 5 1/4 | 5.25 | 0.1649 | 5.3055 | 0.0072 | 3.25 | 195 |
| 0.50 | 0.0014 | 5 1/2 | 5.50 | 0.1688 | 5.4304 | 0.0074 | 3.32 | 199 |
| 0.50 | 0.0014 | 5 3/4 | 5.75 | 0.1726 | 5.5524 | 0.0076 | 3.40 | 204 |
| 0.50 | 0.0014 | 6 | 6.00 | 0.1763 | 5.6719 | 0.0077 | 3.47 | 208 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| **Vent Hole** | | | | | | | | |
| 0.75 | 0.0031 | 1/16 | 0.06 | 0.0180 | 0.5789 | 0.0018 | 0.80 | 48 |
| 0.75 | 0.0031 | 1/8 | 0.13 | 0.0254 | 0.8187 | 0.0025 | 1.13 | 68 |
| 0.75 | 0.0031 | 3/16 | 0.19 | 0.0312 | 1.0027 | 0.0031 | 1.38 | 83 |

| Dia | Area | Water Ht | Water Ht | Time | velocity | Q | Q | Q |
|---|---|---|---|---|---|---|---|---|
| inches | Ft2 | inches | inches | sec | fps | cfs | gpm | gph |
| 0.75 | 0.0031 | 1/4 | 0.25 | 0.0360 | 1.1578 | 0.0036 | 1.59 | 96 |
| 0.75 | 0.0031 | 1/2 | 0.50 | 0.0509 | 1.6373 | 0.0050 | 2.25 | 135 |
| 0.75 | 0.0031 | 3/4 | 0.75 | 0.0623 | 2.0053 | 0.0062 | 2.76 | 166 |
| 0.75 | 0.0031 | 1 | 1.00 | 0.0720 | 2.3155 | 0.0071 | 3.19 | 191 |
| 0.75 | 0.0031 | 1 1/4 | 1.25 | 0.0805 | 2.5888 | 0.0079 | 3.56 | 214 |
| 0.75 | 0.0031 | 1 1/2 | 1.50 | 0.0882 | 2.8359 | 0.0087 | 3.91 | 234 |
| 0.75 | 0.0031 | 1 3/4 | 1.75 | 0.0952 | 3.0632 | 0.0094 | 4.22 | 253 |
| 0.75 | 0.0031 | 2 | 2.00 | 0.1018 | 3.2747 | 0.0100 | 4.51 | 271 |
| 0.75 | 0.0031 | 2 1/4 | 2.25 | 0.1080 | 3.4733 | 0.0107 | 4.78 | 287 |
| 0.75 | 0.0031 | 2 1/2 | 2.50 | 0.1138 | 3.6612 | 0.0112 | 5.04 | 302 |
| 0.75 | 0.0031 | 2 3/4 | 2.75 | 0.1194 | 3.8399 | 0.0118 | 5.29 | 317 |
| 0.75 | 0.0031 | 3 | 3.00 | 0.1247 | 4.0106 | 0.0123 | 5.52 | 331 |
| 0.75 | 0.0031 | 3 1/4 | 3.25 | 0.1298 | 4.1744 | 0.0128 | 5.75 | 345 |
| 0.75 | 0.0031 | 3 1/2 | 3.50 | 0.1347 | 4.3320 | 0.0133 | 5.97 | 358 |
| 0.75 | 0.0031 | 3 3/4 | 3.75 | 0.1394 | 4.4840 | 0.0138 | 6.17 | 370 |
| 0.75 | 0.0031 | 4 | 4.00 | 0.1440 | 4.6311 | 0.0142 | 6.38 | 383 |
| 0.75 | 0.0031 | 4 1/4 | 4.25 | 0.1484 | 4.7736 | 0.0146 | 6.57 | 394 |
| 0.75 | 0.0031 | 4 1/2 | 4.50 | 0.1527 | 4.9120 | 0.0151 | 6.76 | 406 |
| 0.75 | 0.0031 | 4 3/4 | 4.75 | 0.1569 | 5.0466 | 0.0155 | 6.95 | 417 |
| 0.75 | 0.0031 | 5 | 5.00 | 0.1609 | 5.1777 | 0.0159 | 7.13 | 428 |
| 0.75 | 0.0031 | 5 1/4 | 5.25 | 0.1649 | 5.3055 | 0.0163 | 7.31 | 438 |
| 0.75 | 0.0031 | 5 1/2 | 5.50 | 0.1688 | 5.4304 | 0.0167 | 7.48 | 449 |
| 0.75 | 0.0031 | 5 3/4 | 5.75 | 0.1726 | 5.5524 | 0.0170 | 7.65 | 459 |
| 0.75 | 0.0031 | 6 | 6.00 | 0.1763 | 5.6719 | 0.0174 | 7.81 | 469 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| **Vent Hole** | | | | | | | | |
| 1.00 | 0.0055 | 1/16 | 0.06 | 0.0180 | 0.5789 | 0.0032 | 1.42 | 85 |
| 1.00 | 0.0055 | 1/8 | 0.13 | 0.0254 | 0.8187 | 0.0045 | 2.00 | 120 |
| 1.00 | 0.0055 | 3/16 | 0.19 | 0.0312 | 1.0027 | 0.0055 | 2.45 | 147 |
| 1.00 | 0.0055 | 1/4 | 0.25 | 0.0360 | 1.1578 | 0.0063 | 2.83 | 170 |
| 1.00 | 0.0055 | 1/2 | 0.50 | 0.0509 | 1.6373 | 0.0089 | 4.01 | 240 |
| 1.00 | 0.0055 | 3/4 | 0.75 | 0.0623 | 2.0053 | 0.0109 | 4.91 | 295 |
| 1.00 | 0.0055 | 1 | 1.00 | 0.0720 | 2.3155 | 0.0126 | 5.67 | 340 |
| 1.00 | 0.0055 | 1 1/4 | 1.25 | 0.0805 | 2.5888 | 0.0141 | 6.34 | 380 |
| 1.00 | 0.0055 | 1 1/2 | 1.50 | 0.0882 | 2.8359 | 0.0155 | 6.94 | 417 |
| 1.00 | 0.0055 | 1 3/4 | 1.75 | 0.0952 | 3.0632 | 0.0167 | 7.50 | 450 |
| 1.00 | 0.0055 | 2 | 2.00 | 0.1018 | 3.2747 | 0.0179 | 8.02 | 481 |
| 1.00 | 0.0055 | 2 1/4 | 2.25 | 0.1080 | 3.4733 | 0.0189 | 8.50 | 510 |
| 1.00 | 0.0055 | 2 1/2 | 2.50 | 0.1138 | 3.6612 | 0.0200 | 8.96 | 538 |

| Dia | Area | Water Ht | Water Ht | Time | velocity | Q | Q | Q |
|---|---|---|---|---|---|---|---|---|
| inches | Ft2 | inches | inches | sec | fps | cfs | gpm | gph |
| 1.00 | 0.0055 | 2 3/4 | 2.75 | 0.1194 | 3.8399 | 0.0209 | 9.40 | 564 |
| 1.00 | 0.0055 | 3 | 3.00 | 0.1247 | 4.0106 | 0.0219 | 9.82 | 589 |
| 1.00 | 0.0055 | 3 1/4 | 3.25 | 0.1298 | 4.1744 | 0.0228 | 10.22 | 613 |
| 1.00 | 0.0055 | 3 1/2 | 3.50 | 0.1347 | 4.3320 | 0.0236 | 10.60 | 636 |
| 1.00 | 0.0055 | 3 3/4 | 3.75 | 0.1394 | 4.4840 | 0.0245 | 10.98 | 659 |
| 1.00 | 0.0055 | 4 | 4.00 | 0.1440 | 4.6311 | 0.0253 | 11.34 | 680 |
| 1.00 | 0.0055 | 4 1/4 | 4.25 | 0.1484 | 4.7736 | 0.0260 | 11.69 | 701 |
| 1.00 | 0.0055 | 4 1/2 | 4.50 | 0.1527 | 4.9120 | 0.0268 | 12.02 | 721 |
| 1.00 | 0.0055 | 4 3/4 | 4.75 | 0.1569 | 5.0466 | 0.0275 | 12.35 | 741 |
| 1.00 | 0.0055 | 5 | 5.00 | 0.1609 | 5.1777 | 0.0282 | 12.67 | 760 |
| 1.00 | 0.0055 | 5 1/4 | 5.25 | 0.1649 | 5.3055 | 0.0289 | 12.99 | 779 |
| 1.00 | 0.0055 | 5 1/2 | 5.50 | 0.1688 | 5.4304 | 0.0296 | 13.29 | 798 |
| 1.00 | 0.0055 | 5 3/4 | 5.75 | 0.1726 | 5.5524 | 0.0303 | 13.59 | 816 |
| 1.00 | 0.0055 | 6 | 6.00 | 0.1763 | 5.6719 | 0.0309 | 13.88 | 833 |
| | | | | | | | | |
| **Pick Hole Semicircular area** | | | | | | | | |
| 1.00 | 0.0027 | 1/16 | 0.06 | 0.0180 | 0.5789 | 0.0016 | 0.71 | 43 |
| 1.00 | 0.0027 | 1/8 | 0.13 | 0.0254 | 0.8187 | 0.0022 | 1.00 | 60 |
| 1.00 | 0.0027 | 1/4 | 0.25 | 0.0360 | 1.1578 | 0.0032 | 1.42 | 85 |
| 1.00 | 0.0027 | 1/2 | 0.50 | 0.0509 | 1.6373 | 0.0045 | 2.00 | 120 |
| 1.00 | 0.0027 | 3/4 | 0.75 | 0.0623 | 2.0053 | 0.0055 | 2.45 | 147 |
| 1.00 | 0.0027 | 1 | 1.00 | 0.0720 | 2.3155 | 0.0063 | 2.83 | 170 |
| 1.00 | 0.0027 | 1 1/4 | 1.25 | 0.0805 | 2.5888 | 0.0071 | 3.17 | 190 |
| 1.00 | 0.0027 | 1 1/2 | 1.50 | 0.0882 | 2.8359 | 0.0077 | 3.47 | 208 |
| 1.00 | 0.0027 | 1 3/4 | 1.75 | 0.0952 | 3.0632 | 0.0084 | 3.75 | 225 |
| 1.00 | 0.0027 | 2 | 2.00 | 0.1018 | 3.2747 | 0.0089 | 4.01 | 240 |
| 1.00 | 0.0027 | 2 1/4 | 2.25 | 0.1080 | 3.4733 | 0.0095 | 4.25 | 255 |
| 1.00 | 0.0027 | 2 1/2 | 2.50 | 0.1138 | 3.6612 | 0.0100 | 4.48 | 269 |
| 1.00 | 0.0027 | 2 3/4 | 2.75 | 0.1194 | 3.8399 | 0.0105 | 4.70 | 282 |
| 1.00 | 0.0027 | 3 | 3.00 | 0.1247 | 4.0106 | 0.0109 | 4.91 | 295 |
| 1.00 | 0.0027 | 3 1/4 | 3.25 | 0.1298 | 4.1744 | 0.0114 | 5.11 | 307 |
| 1.00 | 0.0027 | 3 1/2 | 3.50 | 0.1347 | 4.3320 | 0.0118 | 5.30 | 318 |
| 1.00 | 0.0027 | 3 3/4 | 3.75 | 0.1394 | 4.4840 | 0.0122 | 5.49 | 329 |
| 1.00 | 0.0027 | 4 | 4.00 | 0.1440 | 4.6311 | 0.0126 | 5.67 | 340 |
| 1.00 | 0.0027 | 4 1/4 | 4.25 | 0.1484 | 4.7736 | 0.0130 | 5.84 | 351 |
| 1.00 | 0.0027 | 4 1/2 | 4.50 | 0.1527 | 4.9120 | 0.0134 | 6.01 | 361 |
| 1.00 | 0.0027 | 4 3/4 | 4.75 | 0.1569 | 5.0466 | 0.0138 | 6.18 | 371 |
| 1.00 | 0.0027 | 5 | 5.00 | 0.1609 | 5.1777 | 0.0141 | 6.34 | 380 |
| 1.00 | 0.0027 | 5 1/4 | 5.25 | 0.1649 | 5.3055 | 0.0145 | 6.49 | 390 |
| 1.00 | 0.0027 | 5 1/2 | 5.50 | 0.1688 | 5.4304 | 0.0148 | 6.65 | 399 |
| 1.00 | 0.0027 | 5 3/4 | 5.75 | 0.1726 | 5.5524 | 0.0151 | 6.80 | 408 |
| 1.00 | 0.0027 | 6 | 6.00 | 0.1763 | 5.6719 | 0.0155 | 6.94 | 417 |