AGREEMENT FOR MAINTENANCE OF STORM WATER DETENTION SYSTEM

This agreement is made on August 13, 2021, by **Redwood Rochester Hills East Avon Road MI P1 LLC,** an Ohio Limited Liability Company, whose address is **7007 East Pleasant Valley Road, Independence, OH 44131** ***("OWNER")***, and the CITY OF ROCHESTER HILLS (the "Municipality"), whose address is 1000 Rochester Hills Drive, Rochester Hills, MI 48309.

RECITALS:

WHEREAS, OWNER owns and occupies the property described in attached **Exhibit A**; and

WHEREAS, OWNER has proposed, and the Municipality has approved, a storm water drainage and detention system (the "SYSTEM"), which includes a detention based, for the property as described and depicted in the attached **Exhibit B**; and

WHEREAS, the parties will benefit from the proper use and maintenance of the SYSTEM and desire to enter into this agreement to provide for the same.

THEREFORE, the parties agree:

1. **Use of the System:** Components of the SYSTEM, including the detention basin, shall be used solely for the purpose of detaining storm and surface water on the property until such time as: (i) The Municipality may determine and advise OWNER or OWNER'S successors, grantees or assigns, in writing that it is no longer necessary to use the detention basin to detain storm or surface water; and (ii) An adequate alternative for draining storm and surface water has been provided which is acceptable to the Municipality and which includes the granting of such easements to the Municipality or third parties for the alternative drainage system as may be necessary.

2. **Maintenance:**

A. OWNER shall be responsible for the proper maintenance, repair and replacement of the SYSTEM and any part thereof, including the detention basin as detailed in the Maintenance Plan attached as **Exhibit C**.

B. Proper maintenance of the SYSTEM shall include, but not limited to: (i) Keeping the bottom of the detention basin free from silt and debris; (ii) Removing harmful algae; (iii) Maintaining steel grating across the basin's inlets; (iv) Controlling the effects of erosion; and (v) Any other maintenance that is reasonable and necessary in order to facilitate or accomplish the intended function and purpose of the SYSTEM.

3. **Action by Municipality:** In the event OWNER or OWNER'S successors, grantees or assigns, neglects or fails at any time to properly maintain the SYSTEM or any part thereof, the Municipality may notify OWNER or OWNER'S successors, grantees or assigns, in writing, and the notice shall include a listing and description of maintenance deficiencies and a demand that they must be corrected within thirty (30) days. The notice shall further specify the date and place for a hearing

to be held at least fourteen (14) days after the date of the notice before the City Council, or such other board or official to whom the City Council may delegate responsibility. At the hearing, the City Council (or other board or official) may endorse or modify the listing and description of deficiencies to be corrected and, for good cause, may extend the time within which the deficiencies must be corrected.

4. Thereafter, if the maintenance deficiencies are not corrected within the time allowed, the Municipality may undertake and make the necessary corrections, and may maintain the SYSTEM for a period not to exceed one (1) year. Such maintenance of the SYSTEM by the Municipality shall not be deemed a taking of the property, nor shall the Municipality's actions be deemed to vest in the public any right to use the property. If the Municipality determines maintenance of the SYSTEM by the Municipality should continue beyond one year, the Municipality shall hold, and provide advance written notice of, a further hearing at which OWNER or OWNER'S successors, grantees or assigns, will not or cannot properly maintain the SYSTEM, the Municipality may continue to maintain the SYSTEM for another year, and subject to a similar hearing and determination, in subsequent years.

5. In the event the Municipality determines an emergency condition caused by or relating to the SYSTEM threatens the public health, safety or general welfare, the Municipality shall have the right to immediately and without notice enter the property and undertake appropriate corrective action.

6. **Charges:** The Municipality shall charge to the current owner of the property the cost of maintenance or other corrective action undertaken by the Municipality in accordance with this agreement, plus a ten percent (10%) administrative fee. If not timely paid, the Municipality may assess the charges on the Municipality's tax roll, which charges shall be a lien on the real property and shall be collectable and enforceable in the same manner general property taxes are collected and enforced.

7. **Notice:** Any notices required under this agreement shall be sent by certified mail to the address for each party set forth below, or to such other addresses as such party may notify the other parties in writing:

To OWNER:

Redwood Rochester Hills East Avon Road MI P1LLC
an Ohio Limited Liability Company
7007 East Pleasant Valley Road
Independence, OH 44131

To the Municipality:

Clerk
City of Rochester Hills
1000 Rochester Hills Drive
Rochester Hills, MI 48309

8. **Reserved.**

9. Reserved.

10. That Owner is obligated to reimburse the Municipality for all reasonable expenses incurred in carrying out the obligations of this agreement, including the preparation and execution of this agreement.

11. This Agreement shall be binding upon Owner and the Municipality, their heirs, assigns, successors in interest and successors in office and be deemed to run with the land in perpetuity.

12. Once executed this agreement shall be recorded with the Oakland County Register of Deeds and Owner shall pay all costs for recording.

(Signatures and acknowledgement on following pages)

IN WITNESS WHEREOF, the ~~Municipality has~~ Parties have here unto affixed their signatures this 13th day of August, **2021.**

Redwood Rochester Hills East Avon Road MI P1 LLC,
an Ohio limited liability company

By: _____
David Conwill
Its: Authorized Manager

ACKNOWLEDGEMENT

STATE OF OHIO)
)SS:
COUNTY OF CUYAHOGA)

On this 13th day of August, **A.D., 2021**, before me a Notary Public in and for said County appeared **David Conwill,** to me personally known, who being by me duly sworn, did say that he is/they are the Authorized Manager of **Redwood Rochester Hills East Avon Road MI P1 LLC, an Ohio limited liability company,** and that said Agreement was signed on behalf of said Company by David Conwill who executed the foregoing instrument and acknowledged the same to be his/ their free act and deed for said Company.

Notary Public

NOTARIAL SEAL
STATE OF OHIO
CHARLES B. GRASSER
NOTARY PUBLIC
FOR THE
STATE OF OHIO
My Commission Expires

Cuyahoga County, OHIO

My Commission Expires: 08/11/2024

Drafted By:
Paul Furtaw
7050 W Saginaw Hwy
Lansing, MI 48917

When Recorded Return To:
Clerks Department
City of Rochester Hills
1000 Rochester Hills Drive
Rochester Hills, MI 48309

John Staran
Approved 8/19/21

CITY OF ROCHESTER HILLS

By:_____
Bryan K. Barnett, Mayor

STATE OF MICHIGAN
COUNTY OF OAKLAND

The foregoing instrument was acknowledged before me on _____, 2021, by Bryan K. Barnett, Mayor of the City of Rochester Hills, a Michigan municipal corporation, on behalf of the corporation.

_____
, Notary Public
Oakland County, Michigan
My Commission Expires:

Drafted By:
Paul Furtaw
7050 W. Saginaw Hwy.
Lansing, MI 48917

When Recorded Return To:
Clerks Department
City of Rochester Hills
1000 Rochester Hills Drive
Rochester Hills, MI 48309

EXHIBIT A

LEGAL DESCRIPTION

A parcel of land in the East 1/2 of the Southeast 1/4 of Section 13, Town 3 North, Range 11 East, City of Rochester Hills, Oakland County, Michigan described as:

Beginning at the Southeast corner of said Section 13, thence South 86 degrees 37 minutes 00 seconds West, 1374.48 feet along the South line of Section 13; thence North 0 degree 16 minutes 47 seconds East, 1257.82 feet to the centerline of Avon Road; thence North 72 degrees 25 minutes 31 seconds East, 130.66 feet and North 68 degrees 25 minutes 11 seconds East, 76.89 feet along the centerline of Avon Road; thence South 22 degrees 41 minutes 00 seconds East, 378.86 feet; thence North 65 degrees 14 minutes 30 seconds East, 313.61 feet; thence South 44 degrees 15 minutes 30 seconds East, 160.00 feet; thence North 65 degrees 14 minutes 30 seconds East, 159.13 feet to the centerline of Dequindre Road; thence South 44 degrees 15 minutes 30 seconds East, 156.15 feet along said centerline; thence South 36 degrees 35 minutes 30 seconds East, 620.90 feet along said centerline to its intersection with the East line of said Section 13; thence South 0 degree 34 minutes 44 seconds East, 367.91 feet along said East line to the point of beginning. Containing 1,300,192.18 square feet or 29.848 acres, more or less. Subject to rights of the public over the North 33 feet for Avon Road and the Easterly 33 feet for Dequindre Road.

Tax Parcel No.: 70-15-13-476-005
Commonly known as: 51171 Dequindre Road, Rochester Hills, Michigan

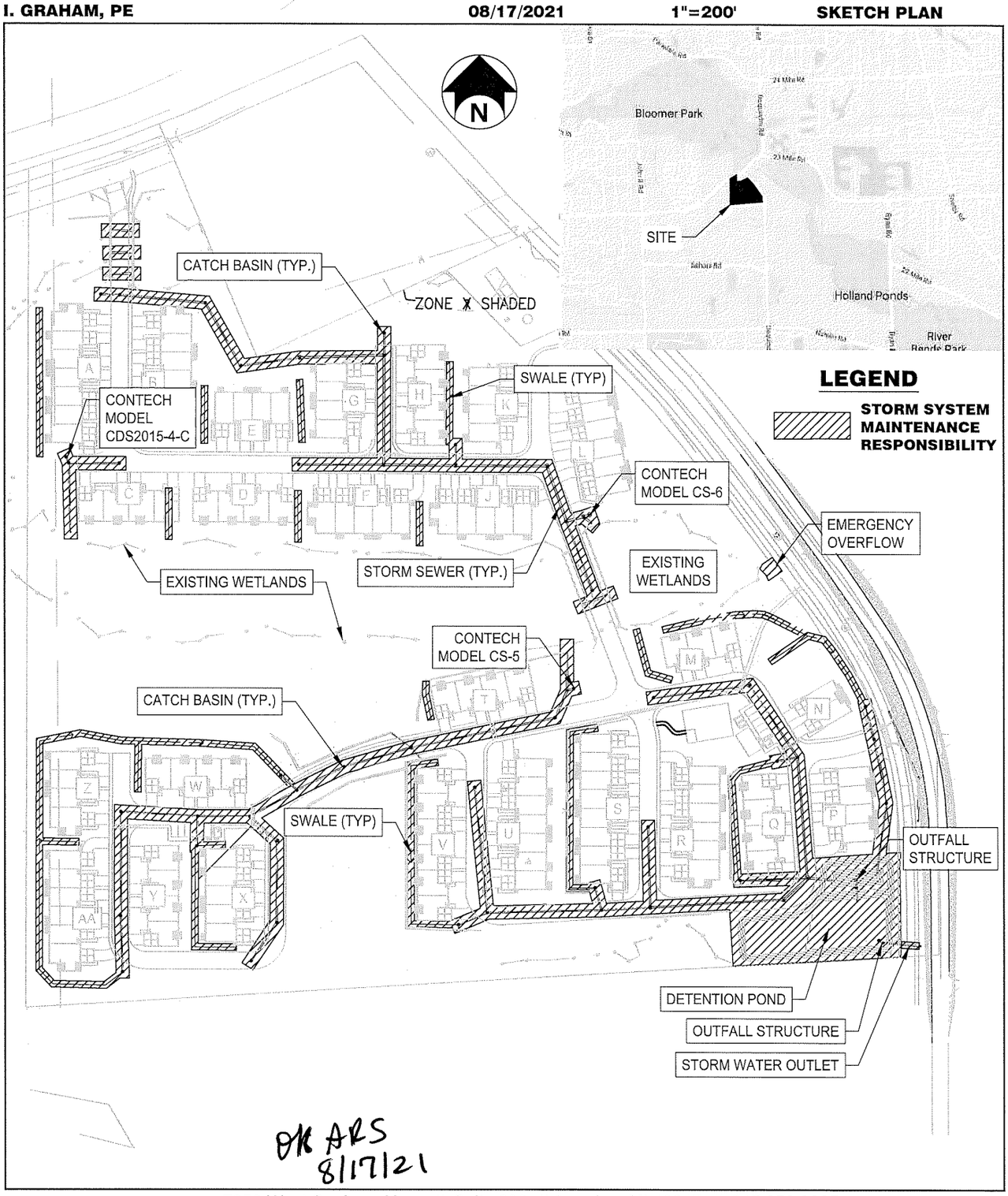
Exhibit Approved
Date: 3/30/21 JM

EXHIBIT B

BERGMANN
ARCHITECTS ENGINEERS PLANNERS

REDWOOD LIVING
ROCHESTER HILLS, MICHIGAN

REFERENCE DOCUMENT:		JOB #:	DRAWING NO.:
PRIVATE MAINTENANCE AGREEMENT		**12963.00**	**EXHIBIT B**
BY:	**DATE:**	**SCALE:**	**DRAWING TITLE:**
I. GRAHAM, PE	**08/17/2021**	**1"=200'**	**SKETCH PLAN**



OK ARS
8/17/21

7050 West Saginaw Hwy. // Suite 200 // Lansing, MI 48917 // 517.272.9835

Exhibit 'C'

Operations and Maintenance Manual

Redwood Rochester Hills

Storm Water System Maintenance Plan

Rochester Hills, MI

Developer:

Redwood Rochester Hills East Avon Road MI P1 LLC

7510 East Pleasant Valley Road

Independence, OH 44131

OK ARS
8/17/21

Operation and Maintenance Manual

INTRODUCTION

This manual identifies the ownership, operation and maintenance responsibilities for all stormwater management systems including the detention basin, drainage swales, underground storm sewer system, manhole and catch basins, and water quality pre-treatment devices as incorporated into and detailed on the approved site plans. IN order to comply with the local best management practices (BMP) and requirements, this manual should serve as a minimum performance standard. This manual should be retained intact and read in its entirety by all parties responsible for the operations and maintenance of the on-site BMP's.

Developer

Redwood Rochester Hills East Avon Road MI P1 LLC

7510 East Pleasant Valley Road

Independence, OH 44131

Property Information

This Operations and Maintenance Manual covers the storm sewer systems located at the property described in Exhibit A to the Redwood Rochester Hills Storm Water System Maintenance Agreement, dated August 13 **, 2021.**

Storm Water System Maintenance Exhibit

Exhibit B of the Storm Water System Maintenance Agreement is the construction drawings of Redwood Rochester Hills, which depict the storm sewer system and the components thereof. This system is subject to the long-term operation and maintenance responsibilities detailed in this manual. The system includes:

- **Storm Sewer Pipes**
- **Storm Structures (manholes, inlets, catch basins, flared end sections, etc)**
- **Detention Basin and Forebay**
- **Pre-treatment devices (Contech Model Numbers CDS2015-4-C, CS-5, and CS-6)**
- **Emergency overflow weirs**
- **Drainage Swales**

Inspections

The frequency of system inspections outlined in the manual and attached exhibits should be considered the minimum, if no events warrant additional inspections. The frequency of inspections should be fine-tuned over time as system specific conditions are better known and the rate at which certain maintenance operations need to be preformed is better understood. Maintenance Inspection Checklists are provided for each of the BMP's in this system. Inspections should be performed by personnel responsible for maintenance and may need to be certified for confined space entry, depending on the component being inspected. Operation of the detention basin and outlet control structures may need to be inspected by a practicing civil engineer familiar with their operation.

Records of all routine inspections and any work performed on the system for maintenance, repair or replacement should be maintained by the owner and kept for a minimum of five (5) years. A copy of all records should be provided to the City of Rochester Hills Engineering Division. The records should include this manual, all inspection sheets, approved construction plans and as-built documents, a maintenance of work performed to the system(s) and contact information for the system inspector, civil engineer, landscape architect, geotechnical engineer and contractor involved with the system.

Storm Water System Maintenance

Regular inspection and maintenance of BMP's are necessary if these facilities are to consistently perform up to expectations. Storm sewer systems are expected to perform quality and quantity

control functions as long as the land use they serve exists. Failure to maintain these systems can create the following adverse impacts:

- Increased pollutants to surrounding surface water features
- Potential loss of life or property resulting from catastrophic failure of the facility
- Aesthetic or nuisance conditions, such as mosquitoes or reduced property values due to a degraded facility appearance

Most of these impacts can be avoided through proper and timely inspection and maintenance. A major concern associated with these impacts is the general public's expectations related to the quality of life provided, in part, by construction of these systems. Inadequate maintenance means the general public may have a false sense of security. The most common cause of storm sewer failure is lack of adequate and proper operation, inspection, maintenance and management.

Good design and construction can reduce subsequent maintenance needs and costs, but they cannot eliminate the need for maintenance altogether. Maintenance requires a long term commitment of time, money, personnel and equipment. Monitoring the overall performance of the stormwater management system is a major aspect of any maintenance program.

The maintenance responsibilities for these systems lie with the current property owner and transfer with the property in perpetuity. If maintenance of the system is not performed, the City of Rochester hills reserves the right to enter the property and perform all necessary work at the property owners' cost. Refer to the Storm Sewer Maintenance Agreement, dated _____, 2021 for additional details.

GENERAL MAINTENANCE ITEMS

Trash Debris Removal:

Removal of trash and debris from all areas of the property should be preformed regularly, and at a minimum monthly. Removal of these items will prevent damage to vegetated areas and eliminate their potential to inhibit the operation of any of the storm water management systems. Sediment, debris and trash that are removed and collected should be disposed of according to local, State and Federal regulations at suitable disposal and/or recycling centers.

STORM WATER SYSTEM MAINTENANCE ITEMS

The following narratives give an overview of the maintenance requirements of the different components of the storm sewer system. The inspection checklists attached to this report offer a more complete listing of what should be inspected, when inspection should occur and the likely frequency of maintenance activities.

Storm Sewer and Structures

Catch basins, inlets, manholes and sewer pipes should be inspected to check for sediment accumulation and clogging, floatable debris, dead vegetation etc. The structures and sewers should also be observed during a wet weather event to ensure their proper operation. Accumulated sediment and debris should be removed on an annual basis or as needed based on observed conditions. Structural repairs or maintenance should occur as needed based on observed conditions such as cracks, spalling, joint failure, leakage, misalignment or settlement of structures, A civil engineer should be retained if problems are thought to exist.

Detention Basin Outlet Control Structure, Overflow Structure, and Overflow Weir

The outlet control, overflow structure, and connecting pipes to the detention basin should be inspected for sediment accumulation, floatable debris, trash and any other foreign matter that may impede flow or restrict the devices from working properly. The stone jacket surrounding the outlet structures should be inspected for sediment build up, and the orifice holes at the base of the structure shall be inspected to make sure they do not become blocked. The grates at the top of the structures should be inspected for structural integrity and build up of debris. The outlet control system should be inspected during a wet weather event to ensure all components are functioning properly. A civil engineer should be retained if problems are thought to exist.

Maintenance will include the removal of any debris, trash or sediment from the structure and/or pipes, cleaning of the stone jacket. The stone jacket may need to be replaced if cleaning does not adequately remove sediment build-up.

Detention Basin

The inlet pipes to the basin should be inspected for structural integrity (pipes cracked, broken, spalled, etc.) and that the grates are free from debris. The area around and immediately downstream of the inlet pipes should be inspected for sediment build-up, erosion and the riprap should be inspected for integrity and sedimentation. Maintenance of the inlet pipes would include removal of any sediment build-up and debris, repair or replacement of any components that are in need of attention and to restore any areas that have eroded.

The basin should be inspected for healthy grass growth, side slope erosion, and excessive sedimentation. The riprap spillway between the basin should be inspected for sedimentation, erosion, and overall integrity. The basin should be inspected during a wet weather event to ensure all aspects of the basin are functioning correctly. A civil engineer should be retained if problems are thought to exist or if the inspection personnel are not familiar with the operating conditions of the basin.

The planted vegetation within the basin should conform to that shown on the construction plans, and any invasive species should be removed. The vegetation should be inspected for healthy growth by a landscape architect if the inspection personnel are not familiar with the specific plantings inside the basin.

Any resident complaints regarding the basin's aesthetics or operation should be investigated during inspections and wet weather operations.

Swales

Drainage swales should be kept free of trash, debris, or any other foreign matter that would inhibit proper drainage. Drainage swales shall be inspected for signs or erosion and/or lack of overall vegetation. The swale catch basins should be checked for structural integrity as mentioned above for the storm sewer structures.

Stormwater Pre-Treatment Devices (Contech)

Inspections and maintenance shall be done according to the attached maintenance manual from the manufacturer for all pre-treatment structures.

The following pages include inspection checklists for the various devices and components listed above as well as the manufacturer's manuals for the stormwater pre-treatment structures.

Inspection Schedule & Checklist

Typical Inspection / Maintenance Schedule for Stormwater Pond Facilities

Activity	Schedule/Frequency
Inspect pond area for oil sheens or trash	Monthly
Inspect exterior of catch basins	Monthly and after storm
Inspect pond area, sidewalls, and shoreline for erosion, settlement, rodent damage, and insects	Quarterly
Inspect fences, gates and locks	Quarterly
Inspect bioswales for vegetation cover and bare areas	Quarterly
Inspect ditches, check dams, and all visible pipes and culverts for trash, obstructions and other problems	Quarterly and after storm events
Inspect inlets and outlets for trash, obstructions, and vegetation	Quarterly and after storm events
Inspect trash racks, debris barriers, and energy dissipaters	Quarterly and after storm events
Inspect water levels in the pond	After storm events
Inspect pond area for undesirable or poisonous vegetation and noxious weeds	Semi-annually, during growing season
Pond area sediment accumulation (pond bottom)	Annually
Inspect interior of catch basins for debris and sediment	Annually
Inspect spillway for vegetation overgrowth and ease of heavy equipment access	Annually
Inspect inside type 2 catch basins, including flow restrictor/orifice plate	Annually
Inspect access ramps for ease of heavy equipment access	Annually

JB
10/27/20

Stormwater System Inspection Checklist

INSPECTOR'S NAME & DATE:

NAME & ADDRESS OF FACILITY:

GENERAL OBSERVATIONS (IS WATER FLOWING?):

WEATHER:

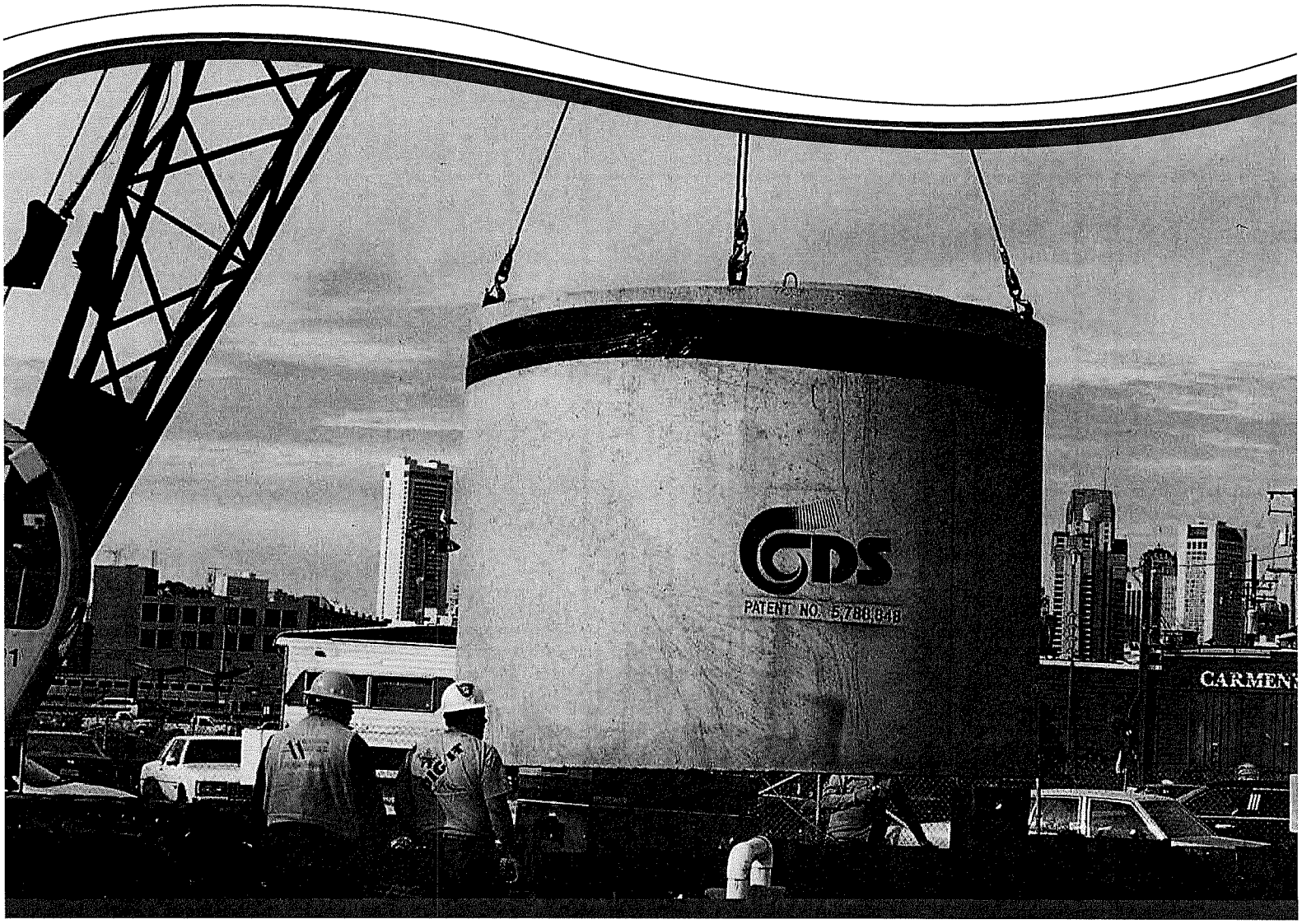
	Checked? (Y/N)	Maintenance Needed? (Y/N)	Maintenance Completed/ Observations & Remarks
Type 1 catch basins			
Look for debris and sediment blocking catch basin grate. If found, remove.			
Inspect filter. Change if torn; clean if clogged; monitor for blockages.			
Look for sediment and trash in catch basin sump. Clean out if sediment fills 60% of the sump or comes within 6" of a pipe.			
Look for damage or cracks to frame, grate, basin walls or bottom. If found, repair or replace.			
Type 2 catch basins			
Remove trash blocking grates or inlets; replace if broken.			
Remove lid and check for sediment accumulation. Remove trash. Remove sediment if more than 1/3 full.			
Check integrity of ladder rungs, cleanout gate, and orifice plate. If bent or obstructed, take appropriate action.			
Have cracks in wall or bottom repaired as necessary.			
Conveyances (ditches, bioswales, culverts, and pipes)			
Check for undercutting, scouring, and slumping. If found, repair or maintain.			
Remove all trash and loose sediment. Remove sediment if it will impede water flow or clog downstream structures.			
Maintain vegetation; mow or cut back if impedes water movement or grass health.			
Repair check dams as necessary.			
Remove any dumped yard waste.			
In ditches and swales, check for integrity of grass, check dams, inlets, and outlets. Remove shrubs and trees.			

	Checked? (Y/N)	Maintenance Needed? (Y/N)	Maintenance Completed/ Observations & Remarks
Components of the pond			
Inlets and **outlets:** remove vegetation and debris. Fix erosion and scouring. Fix cause of sediment found below outlet.			
Remove vegetation and debris from **trash rack.**			
Add rock to **energy dissipater** if missing.			
If necessary, repair rock on **spillway**. Remove trees, shrubs, and vegetation over 4". If piping or erosion is visible, consult engineer.			
Pond			
Check for slumping or sloughing of **walls**. If over 4" of slumping, consult with an engineer. Fix any erosion or scouring. If **leaks**, **piping**, or **soft spots** are found, consult with an engineer.			
If **liner** visible on bottom, check for holes or replace.			
Clean any oil sheen from water with oil-absorbent pads or vactor truck.			
Check **sediment depth** near inlet. If more than one foot exists, or there is build up near inlet, the pond needs to be cleaned.			
Vegetation			
On the **pond walls/side slopes,** mow grass to 4 – 9". Remove clippings. Reseed bare areas.			
On **pond surface**, emergent vegetation over 50% of the area indicates sediment removal needed.			
On **pond bottom**, remove tree seedlings.			
Around the pond, remove trees and shrubs that shade sidewall grass or that might have problem roots near pipes and structures.			
Remove invasive and poisonous plants.			
Remove algae if over 10% of surface.			
Access and Safety			
Check integrity of **access ramp**; ensure stable and clear for heavy equipment.			
Check integrity and operation of all **fences**, **gates**, and **locks**. Repair as needed for ease of access.			
Remove rodents and insects if evidence found.			
Remove vegetation on fences.			

Attach pictures, summary, sketches, and notes as appropriate.

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

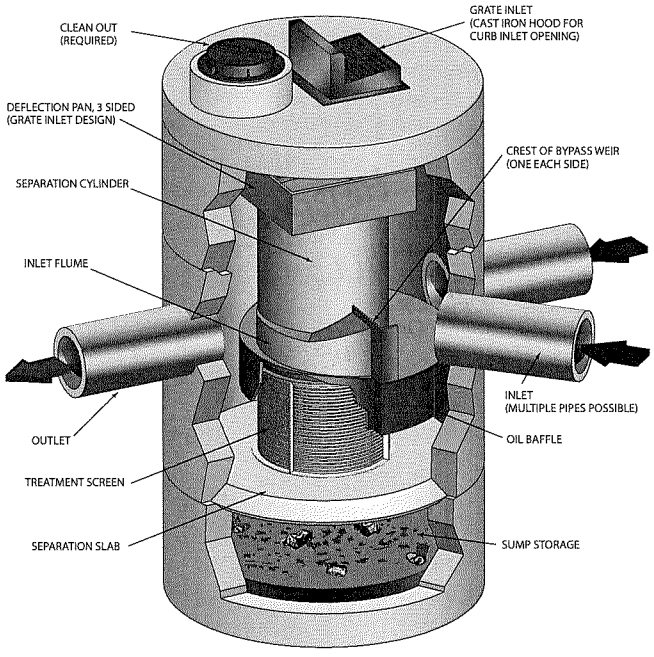
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

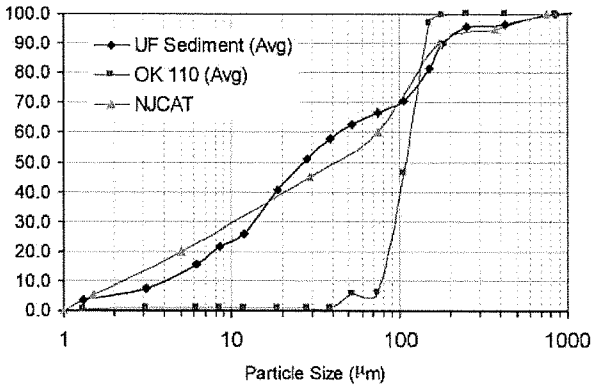


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

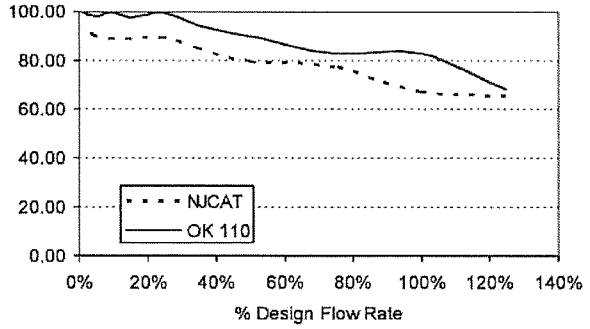


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

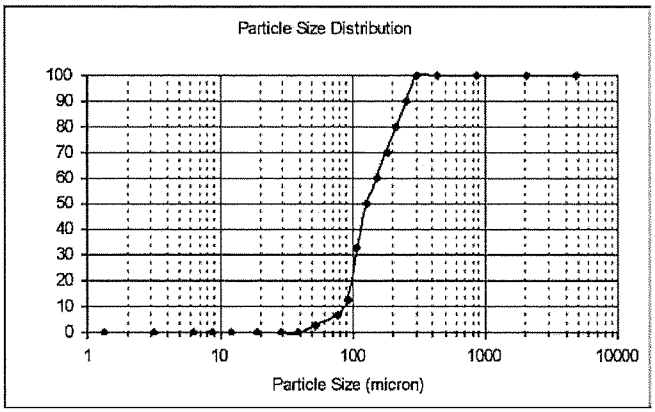


Figure 3. WASDOE PSD

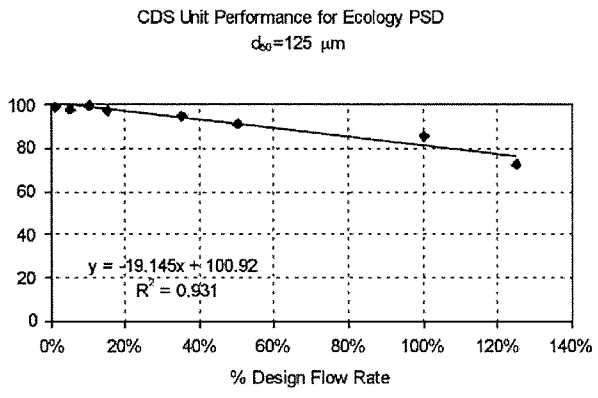


Figure 4. Modeled performance for WASDOE PSD.

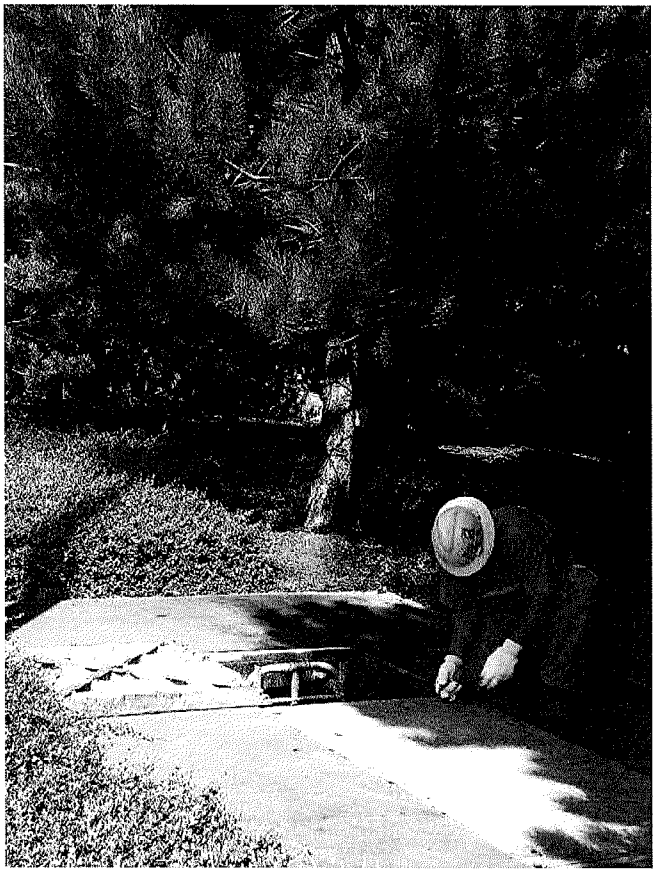
Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified



during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

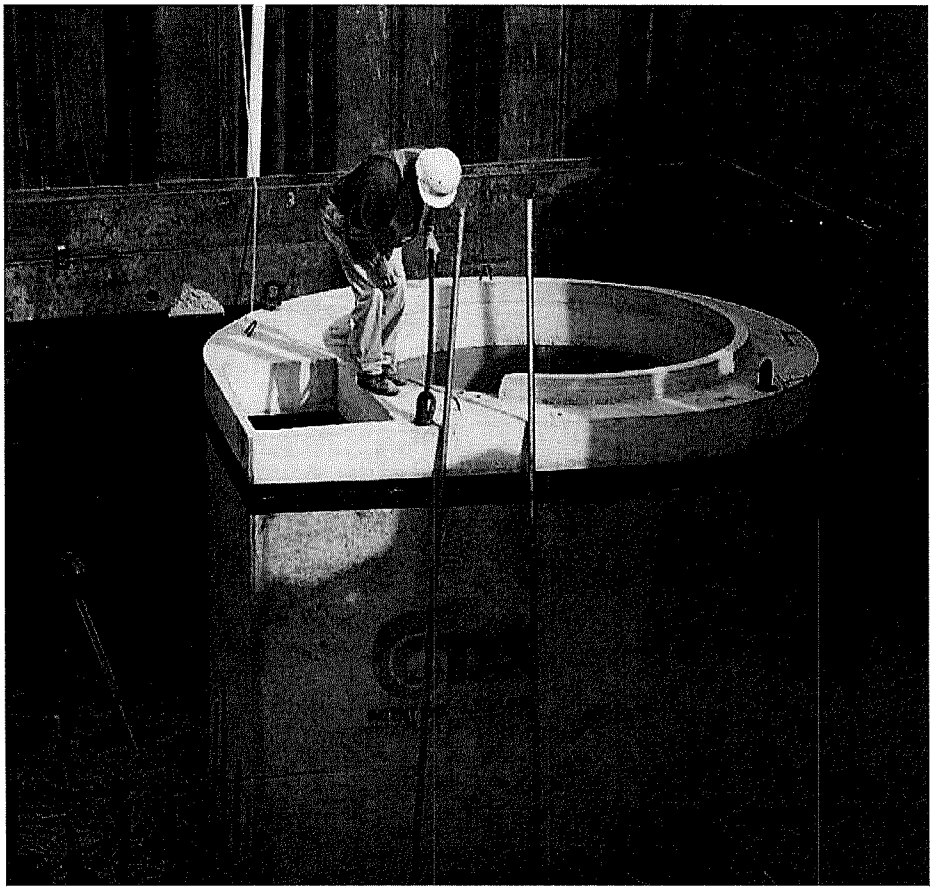
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

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