





# Crematori $\propto$

# The CDS Group Working with nature

C D S

# Cemeteries & Crematori $\infty$

Enjoy your day!

# Groundwater protection: an updated regulatory approach

Name: Paul Doherty Job title: Senior Advisor (Groundwater)

ICCM Seminar - Milton Keynes Date: 7<sup>th</sup> March 2023



# Why is groundwater protection important

- Groundwater is at heart of water environment
  - Fundamental in supporting surface waters / Chalk streams / wetland habitats
  - 1/3 public drinking water
  - 10,000's of private supplies
  - Directly supports agriculture, brewing, food manufacturing, industry, etc





# **Groundwater vulnerable to pollution**

- Many activities can lead to pollution of groundwater
  - Agriculture
  - Urban drainage
  - Landfills
  - Petrol filling stations
  - Cemeteries
  - Out of sight, out of mind
  - Prevention is better than cure



# **Responsibility for protection of groundwater**

- EA has statutory responsibility for managing and protecting England's groundwater
- Apply a risk based and proportionate approach to regulation
  - to all sectors and activities that can potentially impact groundwater quality
  - <u>The Environment Agency's Approach to GW</u>
    <u>Protection</u>
  - Gov.UK <u>Groundwater Protection</u> (landing page)



# Applying a proportionate regulatory framework to cemetery developments

- Environmental Permitting Regulations (EPR) 2016
- EPR 2016 risk based hierarchy of regulatory approach



# Environmental Permitting – groundwater activities

# Current situation

- Cemeteries are 'groundwater activities' under EPR 2016
- Prevent and Limit requirements
- Previously relied on TCP regime to control pollution risk



# Environmental Permitting – groundwater activities

# **Current situation**

- Bespoke permitting introduced in April 2022 for HIGH RISK new cemetery developments
- <u>Protecting</u> <u>groundwater from</u> <u>human burials</u>
- No ability to apply SRs or exemptions



# Environmental Permitting – groundwater activities

#### **The Future**

- We need a risk based, proportionate regulatory regime
- EPR Provides such a framework, but legislative change needed
- Defra Consultation (Sept-Dec 2021) pror



(Sept-Dec 2021) – proposed changes

# **Defra's Consultation – response to the consultation**

- Defra's Consultation of the Groundwater EPR
  amendments Sept December 2021
- Original intention for Consultation response to be published April / May time last year
- The Consultation response is however due to be published imminently
- Cemeteries reassurance
  - Defra and EA very conscious of concerns raised, particularly in relation to existing cemeteries
  - You have been listened too and significant changes in approach have been made

# Applying a proportionate regulatory framework to new cemetery developments





### and any Questions





# Managing Water in Cemeteries Alex Vickers



#### Soils, Water and Risks Posed by Cemeteries – A Basic Introduction to Soils and Water Flow Through Them

# Soil Type and its Effect on Water Movement



# Texture

# Relates to the size of particles

# Structure

# Is the configuration of these particles

# Soil Mineral Fractions

Fraction Name	Diameter (mm)		
Sand	2.00	to	0.05
Very Coarse	2.00	to	1.00
Coarse	1.00	to	0.5
Medium	0.5	to	0.25
Fine	0.25	to	0.10
Very Fine	0.10	to	0.05
Silt	0.05	to	0.002
Coarse	0.05	to	0.02
Medium	0.02	to	0.01
Fine	0.01	to	0.002
Clay	< 0.002		
Coarse	0.00	to	0.0002
Fine	< 0.0002		

# **Relative Sizes**





#### **Texture abbreviations**

- C clay CL clay loam
- ZC silty clay
- ZCL silty clay loam
- ZL silt loam
- SZL sandy silt loam
  - f fine grade
  - c coarse grade

medium grade m

- S sand loamy sand
- LS
- SL sandy loam
- SCL sandy clay loam
- SC sandy clay

# Surface Compaction





# Compaction at Tine Depth

# Porosity and Water Retention

# BALLS!





#### WHICH WILL TAKE THE MOST WATER?





#### Surface Area







# 1 Gram of 0.2 Micron Clay

# Has a Surface Area

= 20 - 80 square metres!



Physical Principles of Soil Drainage



Physical Principles of Soil Drainage





# Physical Principles of Soil Drainage






Soils, Water and Risks Posed by Cemeteries –

## What is the Cause of Poor Drainage?



#### Temporary Water Tables



#### Hydraulic Conductivity and Infiltration Rate



## High / Rising Water Tables



## High Water Tables

#### Bore Hole 2 Results Borough Cemetery





#### **Confined Aquifer**









## **Capillary Rise**



**Two forces cause capillarity** 



#### Drainage Design Consideration (Laboratory Tests)



## Capillary Rise



# Drain spacing and capillary rise



#### Iron Ochre

Migration of Water From Adjacent Land

#### Elevated Land







## Outfall



## Inadequate Outfall



Inadequate Outfall

## Drain Survey





## Achieving Outfall



## Achieving Outfall

## Runoff and Drain Flow Attenuation



#### **Detention Basins**

## Swales



## Attenuation Ponds



## Soakaways





Hydro-cells



## Water Harvesting

## Poor Drainage Design

## Physical principles of soil drainage



## Inappropriate specifications




## **Orientation of Surface Drains**



## Grade/Fall



## Existing Drainage Infrastructure

# Poor Drainage Practice

## Poor Conditions



# Poor Drainage Practice



# Deep Drainage

# Deep Drainage



## Removing Water From at Least 1m Below Burial Depth







## Water Treatment – Reed Beds

# Surface Water Drainage



#### Removing Surface Water Using Shallow Drains



#### Removing Surface Water Using Shallow Drains

#### Combining Shallow Drains With Memorial Headers



Combining Shallow Drains With Memorial Headers



# Raising Land

Lifting the base of a grave at least 1m above the groundwater







## Raising Land



# Raising Land

#### Need relevant EA approvals

# Must avoid contaminating the land



# Thank You!

# Any Questions?

**Discover what's beneath.** 

# **Dremator** $\propto$

**Grave misunderstandings** Justin Smith



#### **Grey Water Contaminants from Cemeteries**

#### **Organic elements and compounds**

- Formalin
- •Ammonium
- •Sulphides
- •Chlorides
- •Mercury

- Virus
- Hepatitis

#### Protozoa

Cryptosporidium

#### Prions

• CJD

#### Bacteria

- Faecal streptococci
- C.difficile
- C.tetani
- Pseudomonas aeruginosa
- Botulism
- Leptospirosis
- Other coliform and clostridia

Home News Northern Ireland

Toxins leaking from embalmed bodies in graveyards pose threat to the living



Formaldehyde used in embalming bodies in cemeteries including Milltown in Belfast could be getting into our water supply

Belfast Telegraph (May 2015)

A study carried out on a cemetery in the West Midlands, located on the second-most important drinking water aquifer in England.

The water table is 5m below the surface. The results revealed that groundwater in proximity to the cemetery, had slightly elevated concentrations of chloride and sulphate, as well as "highly contaminated" levels of pathogenic bacteria.

Groundsure 1<sup>st</sup> November 2019



#### Abstract:

The results showed that most formaldehyde percolated through the soil between week 6 and week 14 of interment, with a greater amount being leached from sand.

Concentrations of up to 15 mg/L formaldehyde were recorded on two occasions, exceeding the tolerable concentration recommended by the World Health Organisation.

- Environmental Earth Sciences Journal 2018
- A laboratory study of the pollution of formaldehyde in cemeteries (South Africa)
- Sunette van Allemann, Jana Olivier & Matthys A. Dippenaa

In an interview with VICE, the former gravedigger, who wishes to be referred to as Dermot, insisted that he had expressed fear to his employers about the risks he and his colleagues were facing on a daily basis. Laborers like Dermot had been handling this toxic water, which was filling graves as quickly as they could dig.

"In the four years I worked there, no protection was given to any grave digger when working in these water-filled graves. We had to wear a normal uniform. Not only were staff being put at risk, but the public were also exposed," Dermot explained.

Vice Publication June 2015



# EU embalming fluid ban 'to change funerals'

(9 23 November 2018 - F Comments





# According to the *Berkeley Planning Journal*, conventional burials in the US <u>every year</u> use:

- 30 million square feet (700 acres) of hardwood.
- 2,700 tons of copper and bronze,
- 104,272 tons of steel,
- 1,636,000 tons of reinforced concrete.
- 3,600,000 litres of formaldehyde

# Formaldehyde



Safety Data Sheet Metasyn 35 SDS Revision Date:

02/18/2014

2.2. Label elements Using the Toxicity Data listed in section 11 and 12 the product is labeled as follows.



Danger

H225 Flammable liquid and vapor. H302 Harmful if availowed. H311 Toxic in contact with skin. H314 Causes severe skin burns and eye damage. H317 May cause an allergic skin reaction. H318 Causes serious eye damage. H330 Fatal if inhaled. H341 Suspected of causing genetic defects. H350 May cause cancer. H351 May cause damage to organs if inhaled or swallowed. H371h May cause damage to organs if inhaled or swallowed. H371h May cause damage to organs if inhaled or swallowed. H371h May cause damage to organs if inhaled or swallowed. H370 Very toxic to aquadic life with long lasting effects.

#### [Prevention]:

P201 Obtain special instructions before use. P202 Do not handle until all safety precautions have been read and understood. P210 Keep away from heat / sparks / open flames / hot surfaces - No smoking. P241 Use explosion-proof electrical / ventilating / light / equipment. P261 Avoid breathing dust / fume / gas / mist / vapors / spray. P264 Wash thoroughly after handling. P270 Do not eat, drink or smoke when using this product. P271 Use only outdoors or in a well-ventilated area. P272 Contaminated work clothing should not be allowed out of the workplace. P273 Avoid release to the environment. P280 Wear protective gloves / eye protection / face protection. P284 Wear respiratory protection. **[Response]:** 

# Dodge

Safety Data Sheet Metasyn 35 SDS Revision Date:

02/18/2014

#### 11. Toxicological information

#### Acute toxicity

Exposure to solvent vapor concentrations from the component solvents in excess of the stated occupational exposure limits may result in adverse health effects such as mucous membrane and respiratory system irritation and adverse effects on the kidneys, liver and central nervous system. Symptoms include headache, nausea, dizziness, fatigue, muscular weakness, drowsiness and in extreme cases, loss of consciousness.

Repeated or prolonged contact with the preparation may cause removal of natural fat from the skin resulting in dryness, irritation and possible non-allergic contact dermatitis. Solvents may also be absorbed through the skin. Splashes of liquid in the eyes may cause irritation and soreness with possible reversible damage.

Ingredient	Oral LD50, mg/kg	Skin LD50, mg/kg	Inhalation Vapor LD50, mg/L/4hr	Inhalation Dust/Mist LD50, mg/L/4hr	Inhalation Gas LD50, ppm
Formaldehyde - (50-00-0)	800.00, Rat -	270.00, Rabbit -	0.578, Rat -	No data	168.00, Rat -
	Category: 4	Category: 3	Category: 2	available	Category: NA
Methanol - (67-56-1)	143.00, Human - Category: 3	15,800.00, Rabbit - Category: NA	128.00, Rat - Category: NA	No data available	64,000.00, Rat - Category: NA
Propylene glycol - (4254-16-4)	No data	No data	No data	No data	No data
	available	available	available	available	available

Item	Category	Hazard
Acute Toxicity (mouth)	4	Harmful if swallowed.
Acute Toxicity (skin)	3	Toxic in contact with skin.
Acute Toxicity (inhalation)	2	Fatal if inhaled.
Skin corrosion/irritation	1B	Causes severe skin burns and eye damage.
Eye damage/irritation	1	Causes serious eye damage.
Sensitization (respiratory)		Not Applicable
Sensitization (skin)	1	May cause an allergic skin reaction.
Germ toxicity	2	Suspected of causing genetic defects.
Carcinogenicity	1B	May cause cancer.
Reproductive Toxicity		Not Applicable
Specific target organ systemic toxicity (single exposure)	2	May cause damage to organs.
Specific target organ systemic Toxicity (repeated exposure)		Not Applicable
Aspiration hazard		Not Applicable



#### LD50

Median Lethal Dose Definition.

The **median lethal dose**, or **LD50**, is a term used in toxicology as a measurement of a lethal dose of a substance (e.g., pathogen, medication, toxic substance, etc.). Specifically, the **LD50** represents the dose at which a substance is lethal for 50% of tested subjects.





	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6		
рН	6.9	6.9	6.5	6.7	6.7	6.6	Screening value	
Temperature on Receipt	5.40	5.40	5.40	5.40	5.40	5.40		
Electrical Conductivity at 20 °C	350	440	580	700	550	280		
Sulphate as SO <sub>4</sub>	23.6	27.0	29.4	123	54.8	21.4	250	mg/l
Ammonium as NH <sub>4</sub>	0.14	0.14	0.16	0.3	0.16	0.19	0.5	mg/l
Total Organic Carbon (TOC)	21.4	12.6	12.5	27.5	15.1	10.3		
Nitrate as N	1.40	1.81	17.7	3.59	19.0	9.63	11.3	mg/l
Nitrite as N	21	67	1600	25	320	280	100	μg/l
Chemical Oxygen Demand (Total)	90	59	60	160	81	180	125	mg/l
Total Oxidised Nitrogen (TON)	1.4	1.9	19	3.6	19	9.9	15	mg/l
Total Chlorine	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		
Dissolved Oxygen	8.7	5.4	6.4	5.4	6.2	6.6		
Heavy Metals / Metalloids								
Calcium (dissolved)	79	92	120	140	100	62	250	mg/l
Iron (dissolved)	0.24	0.16	0.12	0.20	0.17	0.092	0.2	mg/l
Magnesium (dissolved)	7.6	8.8	14	13	11	4.7	50	mg/l
Phosphorus (dissolved)	25.1	145	126	22.3	40.0	89.5	2200	mg/l
Potassium (dissolved)	5.3	6.2	3.1	5.8	6.2	3.9	12	mg/l
Sodium (dissolved)	15	22	21	46	29	7.8	200	mg/l
Environmental Forensics								
Formaldehyde	< 50	< 50	390	< 50	93	84	5	μg/l

# Pathogens
Downstream of								
Burials								
Customer Sample Ref.		ļ.		BH 6				
Sample Matrix	Ground Water	Ground Wa	iter					
Sample Date	16/11/2020	25/02/2021	24/05/2021	28/06/2021	27/07/2021	31/08/2021	24/09/202	1
Sample Time	12:50	00:00	14:00	15:15	13:45	13:50	13:45	
Point Code								
Analyte								
Clostridium Perfringens,								
Conf	0	0	0	1	0	3	4	
Enterococci	47	10	1	500	>10000	5600	52	
Calcium, Filtered as Ca	101	105	107	105	111	109	801	
Iron, Filtered as Fe	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	
Potassium, Filtered as K	3.62	3.55	5.51	6.43	7.43	7.82	7.47	
Sodium, Filtered as Na	7.99	8.17	9.54	12.3	13	13.4	12.8	
рН	7.6	7.4	7.8	7.6	7.4	7.6	7.7	
Conductivity- Electrical								
20C	460	496	493	531	551	568	574	
Ammonium as NH4, Low								
Level	<0.08	<0.08	<0.08	<0.08	0.11	<0.08	<0.08	
Nitrate as N	1.5	1.3	2.2	3.7	4.6	4.7	4.5	
Nitrite as N	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	
Nitrogen, Total Oxidised								
as N	1.5	1.3	2.2	3.7	4.6	4.7	4.5	
Phosphorus, Filtered as								
P	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	
Sulphate as SO4	9.7	10.4	13.4	16.7	20.1	18.8	21.5	
Dissolved Oxygen Fixed	9.1	8.9	7.8	78	7 1	75	67	
BOD + ATU(5 day)	<1	<1	<1	11	4	2	6	
COD (Total)	23	33	105	70	73	48	49	
TOC as C	1.9	1	1.2	1.2	1.8	1.8	1.5	
	1.5			1.2	1.0	1.0	1.5	
Formaldehyde	<0.029	<0.029	0.956	<0.029	<0.029	<0.029	< 0.029	
Total Chlorine	<0.10	<0.10	SEE A/C	SEE A/C	SEE A/C	0.61	SEE A/C	

Regulations: The maximum allowance of enterococci bacteria in drinking water is zero



# Soils are your first line of defence in protecting ground water



# Soils need to be in balance

# Dishing the dirt!

- One teaspoon of soil contains 10 billion microorganisms
- There is sufficient DNA in 1 gm of soil to extend 1,598 km
- 25% of living beings on earth live in the soil
- Soil is technically a living entity
- 95% of all food production relies on soil
- It takes 500 years to produce 25 mm of topsoil
- Topsoil is a nonrenewable resource
- Topsoil is depleting 4 x faster than its being regenerated



Soil is a finite resource! How to screw-up 3,500 years of Mother Natures hard work







# **Understanding soil chemistry important in groundwater protection?**

# Starting with Cation Exchange Capacity (CEC)

## **Cation Exchange Capacity**

Why is CEC important to me as a Cemetery Manager?





## **Cation Exchange Capacity**

What is CEC?

Cation-exchange capacity (CEC) is a measure of how many cations (nutrient elements) can be retained on soil particle surfaces.

# **Cation Exchange Capacity**

What is CEC?

Soil Texture	Typical CEC (Meq/100gm soil)				
Light coloured sands	3-5				
Loams	10-15				
Silty loam	15-25				
Clay and clay loam	20-50				
Organic soils	50-100				
Bentonite	65-95				
Zeolite	180-300				

# Clay soils







# Sandy soils

Soil Texture	Typical CEC (Meq/100gm soil)				
Light coloured sands	3-5				
Loams	10-15				
Silty loam	15-25				
Clay and clay loam	iy loam 20-50				
Organic soils	50-100				
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# Zeolite and mitigation

# Zeolite Molecular Sieve.

## Uses:

- Water filtration
- Medicine
- Anti-bacterial
- Odour suppressant
- Dentistry
- Food additive
- Wound healing
- Radiation contamination clear up







Zeolite amended Sandy soil



Groundwater

# Ash Scattering and Toxicity

# **Cremated Remains composition**

Element	% of ash	Charge	Acid or alkaline
Phosphate	45%	Negative	Alkaline
Calcium	25%	Positive	Alkaline
Sulphate	11%	Negative	Weak Alkaline
Potassium	4%	Positive	Highly Alkaline
Sodium	1.0%	Positive	Alkaline
Chloride	1.0%	Negative	Neutral
Micro-elements	13%	vary	vary

## Ashes increase pH

STRONGLY ACID	MEDIUM	SLIGHTLY ACID	VERY SLIGHTLY ACID	VERY SLIGHTLY ALKALINE	SLIGHTLY	MEDIUM	STRONGLY	ALKAL	INE
			NITR	OGEN				-	-
	-		PHOSP	HORU	S				
			POTA	SSIUM					
-			SUL	PHUR					
	-		CAL	CLUM				-	-
	-	Real Property lies	MAGN	ESIUM				-	
Î	RON	1			_			_	_
MA	NGANESI	E						-	-
B	ORON	1				_			
COPPE	RANDIZ	INC			-	-			_
			1000		MC	LYBDE	NUM		
45 50	55 6	0 6	5 7	0 7	5 8	0 8	5 9.0	9.5	1

#### Ashes increase salinity



Ashes increase sodicity





# Work with nature not against it



Palm Springs 1917



South London 1937

**Managing Water Within Cemeteries** 

# Thank You!

# Any Questions?

# Cremator $\propto$

Cemetery Waste 'An issue not to be buried' Callum Ward BSc FGS

# C D What is Cemetery waste? S

All operational burial facilities across the UK have one thing in common, they all produce excess burial arisings.

- Any material that is to be discarded would be classified as a waste
- It only stops being a waste when something is done to the material

Many burial sites attempt to 'lose' these materials onsite.











- The current legalisation and technical guidance for waste is WM3 ver 1.2GB.
- The purpose of waste classification is to indicate whether a material, in this case excess soil arisings from burial excavations, would be hazardous or non-hazardous. Following which additional WAC analysis can be used to determine which landfill would be appropriate to receive the waste material.
- Cemeteries are listed in Section 20 of the List of Waste (England) 2005 and are listed as a Absolute Non-Hazardous Entry.








### C D S

### The costs of a mis-managed disposal



- A load is roughly 20m<sup>3</sup>
- The above is fees only, doesn't include transport or labour costs

D S

- Landscaped bunds
- Infilling of areas for future burials
- Excess materials could be utilised across your area
- Each cemetery is different











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- Any Questions?
- Drop me an email callum.ward@thecdsgroup.co.uk

# Crematori $\infty$

Planning and Cemeteries

**Ben Copeland** 

## **Environment Agency Regulations**

The regulations cover developments from 1 April 2022 which require new planning permission under section 57 of the Town and Country Planning Act 1990.

The guidance applies to proposals to:

• develop a new cemetery

C D S

• expand an existing cemetery



## Cemeteries & Crematori $\propto$

Identified New Cemetery Site or Extension

## C D S

## **Identified New Cemetery Site or Extension**

#### **Groundwater Assessment**





#### Groundwater Risk Nomograph

# Crematori $\propto$

New Cemetery Required

## **Burial Land Environmental Considerations**

- Groundwater Depth
- Groundwater Source Protection Zone
- Superficial Geology
- Bedrock Geology
- Flood Risk
- Landfill



## **Groundwater Source Protection Zones**

Halture 28 Plei a \$51 Kartin Nerth - Dee Park Envirent 1136.20 Given Fores Fa Stanly Witter Winnersh Inver Larley Temple Park Burghter Garoles Saudhurst Owismon Tacley southere says College Tr

Groundwater source protection zone 1

## **Unsuitable Superficial Deposits**

• Alluvium

C D S

River Terrace
 Deposits



## **Unsuitable Bedrock Geology**

Bagshot
 Formation

- Chalk bedrock
- Lambeth Group



## Areas Directly on Unsuitable Bedrock Geology

 Areas where superficial deposits are absent and directly on the unsuitable bedrock types.



## **Flood Zones**

 Dark blue = Flood Zone 3

C D S

> Light blue = Flood Zone 2



## **Historical Landfill**



## **Overall Constraints Plan**



Кеу	
	SPZ 1
	Unsuitable superficial geology
	Areas directly on unsuitable bedrock
	Flood Zone 3
	Flood Zone 2
	Historical Landfill

C D S

## Next Steps



>10ha site

## Topography



## **Agricultural Land Classification**









## **Policy Designations**



## **Site Allocations**



## **Biodiversity Net Gain**

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Under the Environment Act 2021, all planning permissions granted in England (with a few exemptions) will have to deliver at least **10% biodiversity net gain** from an as yet unconfirmed date in November 2023.



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Designing out constraints

### C D S

## **Constraints Plan**



## Design



## Drematori $\propto$

## Cemetery Extension Planning

## C D S

## **Cemetery Extension Planning**

#### Is the site beyond the geographical extent of an existing cemeteries planning boundary?

 Yes
 Not sure<br/>Or<br/>No

 Full planning permission required
 Two Options:<br/>1) Historic Data Search<br/>2) Certificate of Lawfulness


### **Cemetery Extension Planning**

#### Is it clear on the historic data search that the site is within the planning boundary?



Submit an application to differentiate from the approved layout

Or

#### **Certificate of Lawfulness**

#### What is a lawful development certificate?

A proposed use of buildings or other land, or some operations proposed to be carried out in, on, over or under land, would be lawful for planning purposes under section 192 of the Town and Country Planning Act 1990.

You'll need:

- An application form
- Evidence verifying the information within the application.
- This would include architectural plans and elevations
- A site location plan
- A fee



#### **Certificate of Lawfulness**

# Benefits of a certificate of lawfulness, if approved:

- Covered legally for any burial operation on the site
- Removes the consultation of the Environment Agency from any application with regard to burial use
- The site can operate under the same regulations of the existing site as it is not considered a 'new cemetery'



## **Environment Agency Regulations**

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The guidance applies to proposals to:

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C D S

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**Discover what's beneath.** 

# **Dremator** Ð $\propto$

## Thank you for listening.