Humes

Strength. Performance. Passion.

Stormwater treatment

Issue 6

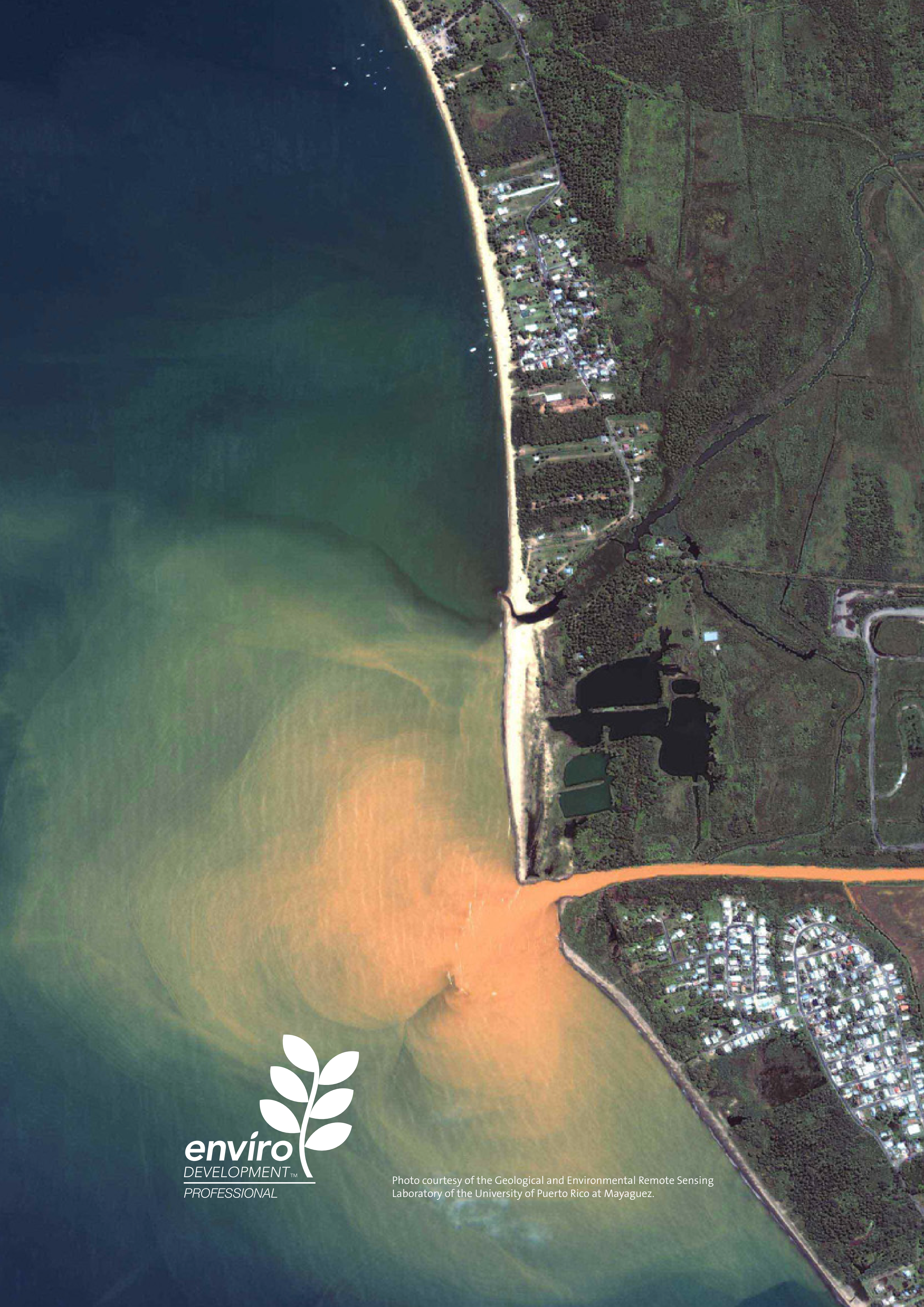

Photo courtesy of the Geological and Environmental Remote Sensing Laboratory of the University of Puerto Rico at Mayaguez.

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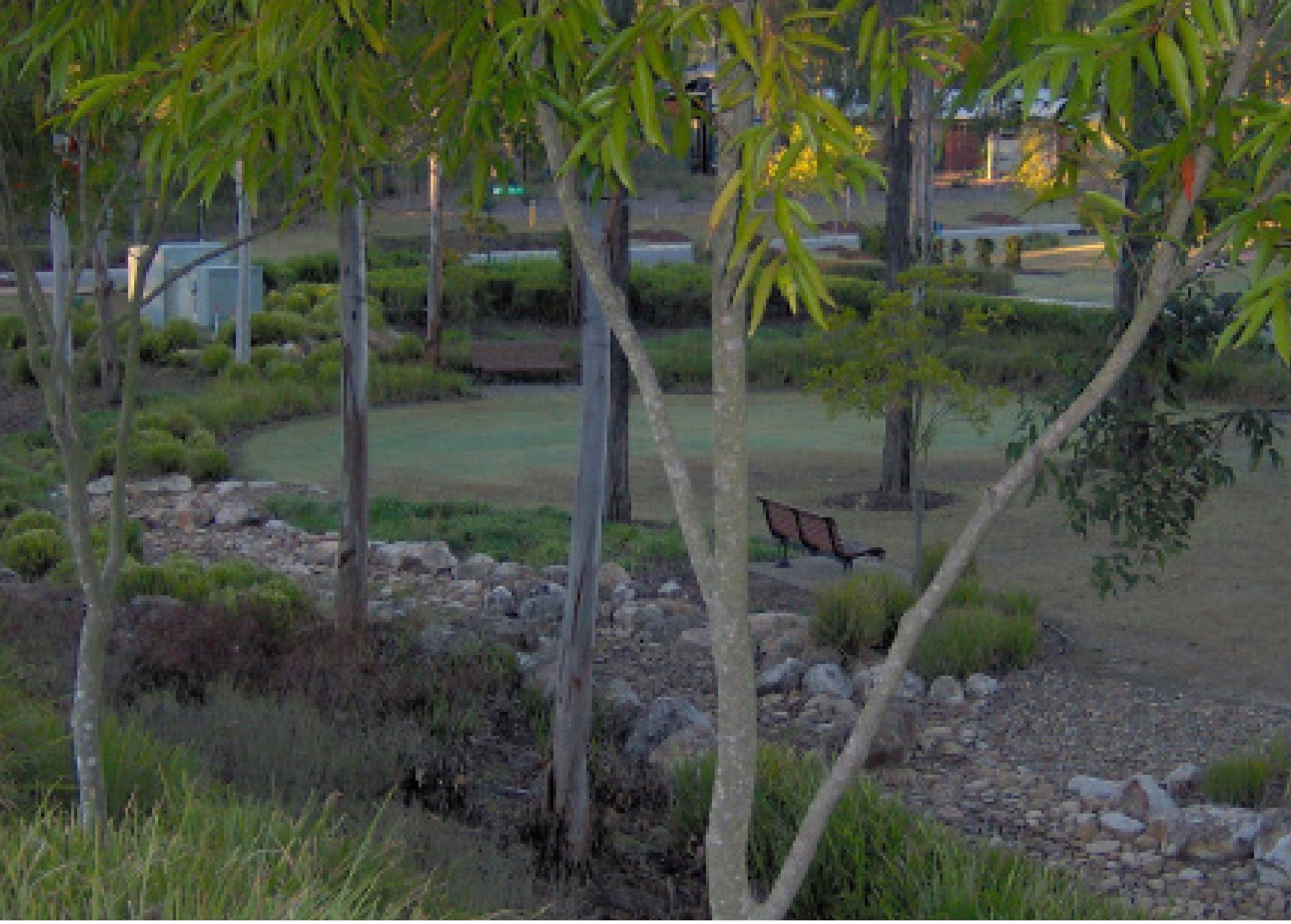


Water Sensitive Urban Design (WSUD)

Top:
WSUD in practice

Originating in the early 1990's, Water Sensitive Urban Design (WSUD) was proposed as a method of designing urban developments to encompass all aspects of the urban water cycle. It aimed to integrate the stormwater, potable (drinking) water, and wastewater cycles to minimise the adverse impact of development.

Principles of WSUD are continually being refined, yet generally include the following:

- protect existing natural features and ecological processes
- integrate public open spaces with stormwater drainage corridors
- maintain natural hydrologic behavior of catchments and preserve the natural water cycle
- protect water quality environmental values of surface and groundwater
- minimise demand on the reticulated water supply system and utilise stormwater as a valued resource
- minimise capital and maintenance costs of stormwater infrastructure and minimise sewage discharges to the natural environment
- integrate water into the landscape to enhance visual, social, cultural and ecological values.

Source: Dept. of Environment Resources and Management 2010.

For Humes and its parent company, LafargeHolcim, sustainable development is a key priority. Our stormwater treatment products demonstrate our commitment to protecting the environment.

Improving stormwater quality

Stormwater runoff from urban areas has been shown to contain a wide variety of pollutants from both natural and man-made sources, with key contaminants including:

- sediment/suspended solids
- litter
- nutrients (nitrogen and phosphorous)
- heavy metals
- pesticides
- hydrocarbons (oil and grease)
- micro-biological organisms.

To minimise the impact of pollutants on receiving waterways many authorities have now set specific Water Quality Objectives (WQO) for the treatment of stormwater runoff from new developments. Due to the complexity and variability of stormwater runoff, and climatic changes across Australia, many authorities have different WQO with load reductions of 80% Total Suspended Solids (TSS), 50% Total Nitrogen (TN), and 50% Total Phosphorous (TP) typical.

Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

MUSIC software was developed as an assessment tool for designers and authorities to identify appropriate stormwater treatment measures to achieve the above WQO for new urban development proposals.

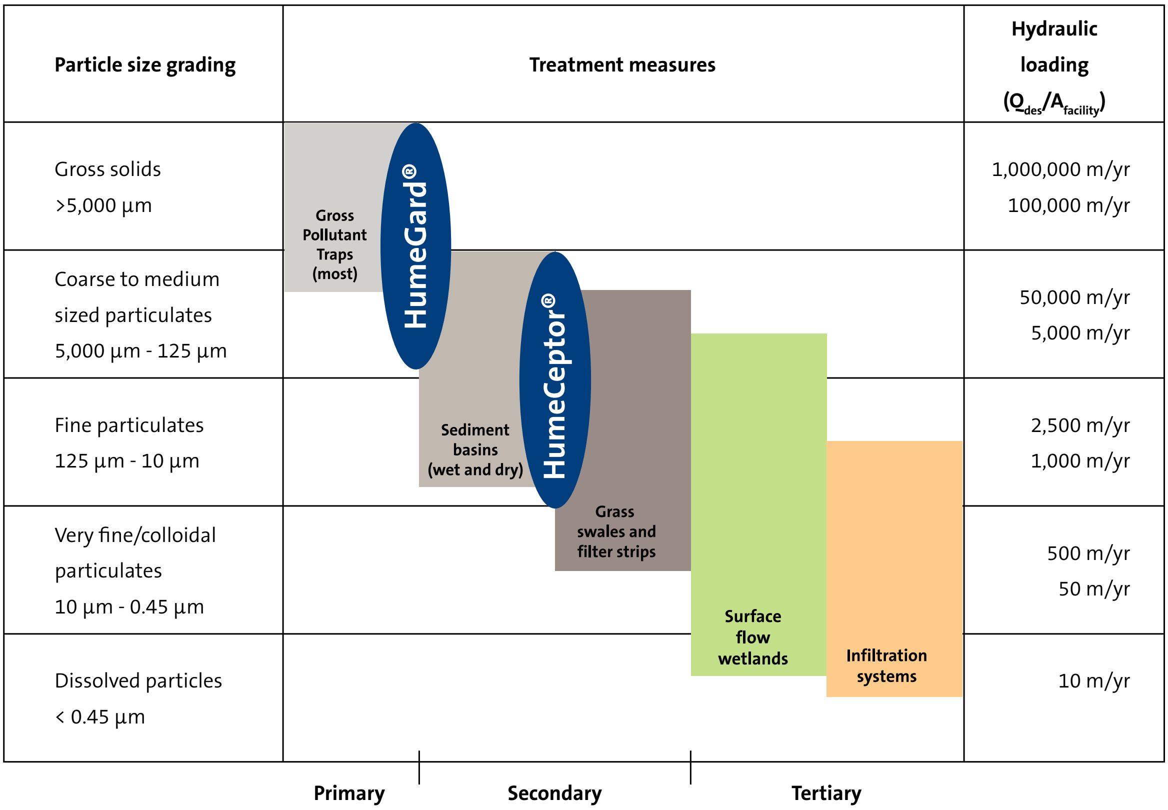
Pollutant removal

Treatment trains

To effectively treat stormwater runoff, it is necessary to utilise different treatment processes to target different pollutants; the combination of which is typically referred to as a 'treatment train'.

Figure 1 demonstrates how specific pollutants must be targeted by higher level treatment measures and how it is helpful to separate them into primary, secondary, and tertiary categories.

Figure 1 – Treatment measure selection guide (adapted from Ecological Engineering 2003)



Primary treatment

HumeGard® Gross Pollutant Trap

The HumeGard® system is a Gross Pollutant Trap (GPT) that is specifically designed to remove gross pollutants and coarse sediments ≥ 150 microns, from stormwater runoff. A wide range of models are available to provide solutions for normal and super-critical flow conditions.

The patented HumeGard® GPT incorporates a unique floating boom and bypass chamber to enable the continued capture of floating material, even during peak flows. The configuration also prevents re-suspension and release of trapped materials during subsequent storm events.

The HumeGard® GPT is designed for residential and commercial developments where litter and sediment are the target pollutants. It is particularly useful in retrofit applications or drainage systems on flat grades where low head loss requirements are critical, and in high backwater situations.

The value of the HumeGard® GPT has proven it to be one of the most successful treatment devices in Australia today:

- **The system provides high performance with negligible head loss**
  The HumeGard® GPT has a head loss 'k' factor of 0.2, important for retrofit and surcharging systems.
- **It captures and stores a large volume of pollutants**
  For pollutant export rates reported by Australia Runoff Quality (1 m^3/hectare/year), the HumeGard® GPT is sized for maintenance intervals up to annual durations.
- **It uses independently proven technology**
  The system was developed and tested by Swinburne University of Technology, Australia, in 1998, to demonstrate compliance with operational criteria from the Victorian EPA.
- **It has low operational velocities**
  Flow velocity in the storage chamber is <0.2 m/s to ensure the comb self-cleans and improves settling of coarse sediment.
- **It retains floating material even in bypass**
  All GPTs bypass at high flows. The patented floating boom will capture and retain floating materials even when bypass occurs.
- **It provides cost effective treatment for litter and coarse sediments**
  The system's large capacity and long maintenance intervals reduces the overall lifecycle costs in comparison with other treatment measures.
- **It can reduce the footprint of the stormwater treatment train**
  Installation of a HumeGard® GPT prior to vegetated treatment measures can assist in reducing their overall footprint.
- **It maximises above ground land use**
  The HumeGard® GPT is a fully trafficable solution, so it can be installed under pavements and hardstands to maximise land use on constrained sites.
- **It is easy to maintain**
  Cleanout of the HumeGard® GPT can be performed safely and effectively from the surface using a vacuum truck.
- **It is made from quality componentry**
  All internal metal components are made from 304 stainless steel or fibreglass, and the system undergoes rigorous quality control prior to dispatch.

System operation

The HumeGard® GPT utilises the processes of physical filtration and floatation/sedimentation to separate the litter and coarse sediment from stormwater runoff. It incorporates an upper bypass chamber diverting treatable flows via a floating boom (refer to Figure 2), and a lower treatment chamber for settling and filtering coarse pollutants from the flow. For more details on the operation of the HumeGard® GPT refer to the technical manual.

Independent verification testing

Laboratory and field testing of the HumeGard® GPT for hydraulic performance and litter capture was conducted in Australia by Swinburne University of Technology, during 1996 and 1998.

Laboratory and field testing (Waste Management Council of Victoria 1998, Trinh 2007, Woods 2005, Swinburne University of Technology 2000) has proven the performance outlined in Table 1 below.

Further field testing was conducted by the University of the Sunshine Coast from 2013 to 2015 to determine TSS, TP and TN removal efficiencies, which are also outlined in Table 1 below.

Figure 2 – HumeGard® system operation during design flow conditions

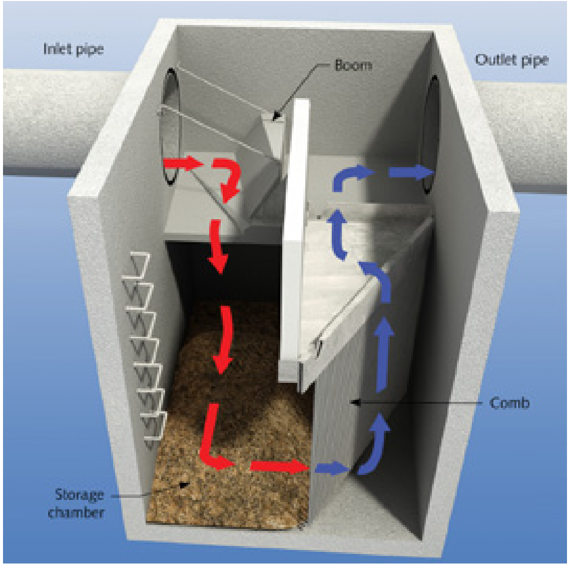


Table 1 – HumeGard® GPT performance summary

Pollutant	Removal efficiency	Details
Gross pollutants (litter, vegetation)	90%	Annually
TSS	41%	Annually (including bypass)
Hydrocarbons	90%	In an emergency spill event
TP	34%	Particulate-bound
TN	24%	Particulate-bound

Notes:
1. Nutrient removal is influenced by individual catchment characteristics and partitioning between dissolved and particulate nitrogen.
2. For further details on performance testing contact Humes Water Solutions.
3. Gross pollutant traps are not specifically designed to capture hydrocarbons, though may do so during emergency spill events. When this occurs, maintenance is required immediately.
4. The unique design of the HumeGard® floating boom allows it to be modified to treat higher flows and capture more gross pollutants and sediment on request.

Options

A wide range of sizes are available to suit catchment pollutant generation rates and Water Quality Objectives (WQO). Table 2 below presents the standard units, their dimensions and the total storage volume.
We recommend that designers contact Humes for detailed sizing on each project and for advice with larger units.

Variants

A number of additional innovations have been made to the HumeGard® GPT to facilitate their effective operation in a wider range of applications:

- Super-critical HumeGard® GPT – designed to operate under supercritical flow conditions in steep, high velocity drainage networks.
- Angled HumeGard® GPT – designed to replace a 45° or 90° junction in a drainage network.
- Dual outlet HumeGard® GPT – designed to divert the Q_{3mth} to downstream natural Water Sensitive Urban Design (WSUD) elements such as wetlands and bio-retention whilst bypassing excess flows through a second outlet.
- Inundated applications – the HumeGard® GPT can be modified to accommodate temporary and permanent inundation of the drainage network.

For more details on the variants and their application refer to the HumeGard® GPT technical manual.

Table 2 – HumeGard® model range and dimensions

HumeGard® model	Pipe diameter or box culvert width (mm)	Width (m)	Length (m)	Depth from pipe invert (m)	Total pollutant capacity (m^3)
HG12	300 - 375	1.8	2.0	1.39	2.0
HG15	450 - 525	1.8	2.0	1.36	2.0
HG18	525 - 675	2.0	2.1	1.10	2.5
HG24	600 - 825	2.7	2.5	1.70	6.8
HG27	750	3.0	2.5	1.60	6.7
HG30	750 - 900	3.4	2.5	2.20	10.6
HG30A	900	3.4	2.5	1.90	9.7
HG35	900	3.9	2.5	2.00	11.3
HG35A	1,050	3.9	2.5	1.80	10.2
HG40	900	4.4	2.9	2.00	14.5
HG40A	1,050	4.4	2.9	1.80	13.2
HG40B	1,200	4.4	2.9	1.60	8.9
HG45	1,200	4.9	2.9	2.10	18.3
HG45A	1,350	4.9	3.2	1.90	18.0
HG50 and larger	>1,500	5.3	3.5	2.00	>20.0

Note: The unique design of the HumeGard® floating boom allows it to be modified to treat a wide range of flowrates. Contact Humes for details on the model to suit your project.

Design information

To design a system suitable for your project it is necessary to review the configuration of the stormwater system, the location and purpose of other stormwater management (WSUD) controls, the catchment area and the hydrology. Refer to the HumeGard® GPT technical manual for a step by step process or contact Humes for assistance.

MUSIC/pollutant export model inputs

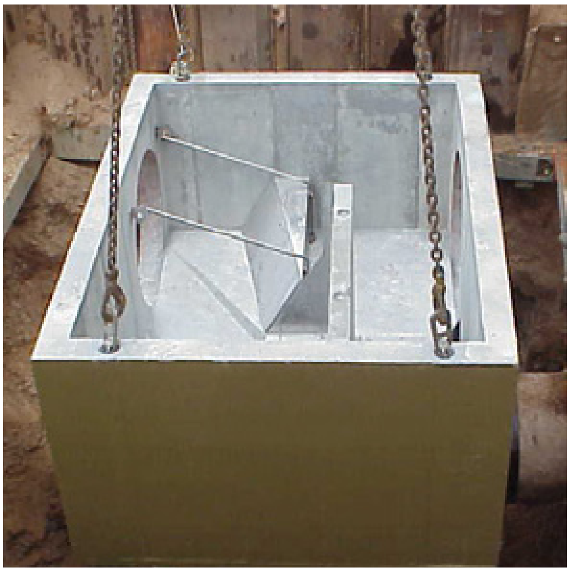
Many local authorities utilise MUSIC or other pollutant export models to assist in stormwater treatment train selection, and recommend generic inputs for GPTs. Considering these against the independent research results, the following conservative removal efficiencies (refer to Table 3 below) are recommended for the HumeGard® GPT on an annual basis (i.e. no bypass).

Table 3 – MUSIC inputs for HumeGard® GPTs

Pollutant	Removal efficiency
Gross pollutants (litter, vegetation)	90%
TSS	41%
TP	34%
TN	24%

Installation

The installation of the HumeGard® unit should conform to the local authority's specifications for stormwater pit construction. Detailed installation instructions are dispatched with each unit.



Left:
HumeGard® Gross Pollutant Trap

Construction sequence

The HumeGard® unit is installed as follows:

1. Prepare the geotextile and aggregate base.
2. Install the main treatment chamber section.
3. Install the main bypass chamber section/s (if required).
4. Fit the stainless steel comb (if required).
5. Connect the inlet and outlet pipes.
6. Place the main chamber lid.
7. Install the frame and access covers.

Maintenance

The design of the HumeGard® GPT means that maintenance is best performed by vacuum trucks or baskets (available upon request), both of which avoid entry into the unit.

Secondary treatment

HumeCeptor® hydrodynamic separator

The HumeCeptor® system is a patented hydrodynamic separator, specifically designed to remove hydrocarbons and suspended solids from stormwater runoff, preventing spills and minimising non-point source pollution entering downstream waterways.

Right: HumeCeptor® system

The HumeCeptor® system is an underground, precast concrete stormwater treatment solution that utilises hydrodynamic and gravitational separation to efficiently remove Total Suspended Solids (TSS) and entrained hydrocarbons from runoff. First designed as an 'at source' solution for constrained, commercial and industrial sites it has been improved and expanded to service large catchments, mine and quarry sites, inundated drainage systems, and capture large volume emergency spill events. The system is ideal for hardstands/wash bays, car parks, shopping centres, industrial/commercial warehouses, petrol stations, airports, major road infrastructure applications, quarries, mine sites and production facilities.

Independently tested, and installed in over 30,000 projects worldwide, the HumeCeptor® system provides effective, and reliable secondary treatment of stormwater for constrained sites.

- **The system reliably removes a high level of TSS and hydrocarbons**
  The HumeCeptor® system was developed specifically to remove fine suspended solids and hydrocarbons from stormwater, and has been certified to achieve high pollutant removal efficiencies for TSS (>80%) and Total Nutrients (TN) (>30%) on an annual basis.
- **It captures and retains hydrocarbons and TSS down to 10 microns**
  Each system is specifically designed to maintain low treatment chamber velocities to capture and retain TSS down to 10 microns. It also removes up to 98% of free oils from stormwater.
- **Each device is sized to achieve the necessary Water Quality Objectives (WQO) on an annual basis**
  Utilising the latest build-up and wash-off algorithms, PCSWMM software for the HumeCeptor® system ensures that the device chosen achieves the desired WQO (e.g. 80% TSS removal) on an annual basis.
- **Its performance has been independently verified**
  The HumeCeptor® system's technology has been assessed by independent verification authorities including the New Jersey Department of Environmental Protection (NJDEP), The Washington Department of Environment (USA), and by the Canadian Environmental Technology Verification program (ETV).

- **The system is proven**
  The HumeCeptor® system was one of the first stormwater treatment devices introduced to Australia, and now after 30,000 installations worldwide, its popularity is testament to its performance, quality and value for money.
- **High flows won't scour captured sediment**
  The unique design of the HumeCeptor® unit ensures that as flows increase and exceed the treatment flow, the velocity in the storage chamber decreases.
- **Nutrients are captured along with the sediment**
  The effective capture of TSS results in the capture of particulate nutrients shown to be >30% of TN and Total Phosphorous (TP).
- **Designs allow for emergency spill storage, directional change, multiple pipes and tidal inundation**
  A new range of HumeCeptor® systems are now available, built specifically to manage emergency spills (50,000 L storage), change of pipe directions, the joining of multiple pipes, or to manage high tail water levels as a result of tides or downstream water bodies.
- **Fully trafficable to suit land use up to Class G**
  The HumeCeptor® system is a fully trafficable solution, it can be installed under pavements and hardstands to maximise above ground land use.

System operation

The HumeCeptor® system slows incoming stormwater to create a non-turbulent treatment environment (refer to Figure 3 below), allowing free oils and debris to rise and sediment to settle. Each HumeCeptor® system maintains continuous positive treatment of TSS, regardless of flow rate, treating a wide range of particle sizes, as well as free oils, heavy metals and nutrients that attach to fine sediment.

The HumeCeptor® system's patented scour prevention technology then ensures pollutants are captured and contained during all rainfall events. For more detail on the operation of the HumeCeptor® system refer to the technical manual.

Figure 3 – HumeCeptor® system operation during design flow condition

Independent verification testing

The HumeCeptor® system has been extensively researched by more than 15 independent authorities to validate its performance; it has now gained Environmental Technology Verification (ETV) certificates from ETV Canada, New Jersey Department of Environment Protection (NJDEP) and Washington Department of Environment (WDOE).

A number of agencies have conducted independent studies; their results from these studies (over 100 test events) have been summarised in Table 4.

Table 4 – HumeCeptor® systems performance summary

Pollutant	Average removal efficiency	Details
TSS	80%	Laboratory and field results, stable, hardstand, roads, commercial and industrial sites
TN	37%	Field results
TP	53%	Field results
Chromium	44%	Field results
Copper	29%	Field results
TPH	65%	<10 ppm inflow concentration
	95%	10 ppm - 50 ppm inflow concentration (typical stormwater)
	99%	>500 ppm inflow concentration (emergency spills)

Note: Detailed reports are presented in the HumeCeptor® system technical manual.

Options

There are a number of HumeCeptor® systems available to meet the requirements of various WQO maintaining catchments and local hydrology. The standard range is detailed in Table 5 below.

Table 5 – HumeCeptor® model range and details

HumeCeptor® model	Pipe diameter (mm)	Device diameter (mm)	Depth from pipe invert* (m)	Sediment capacity (m^3)	Oil capacity (l)	Total storage capacity (l)
STC 2 (inlet)	100 - 600	1,200	1.70	1	350	1,740
STC 3	100 - 1,200	1,800	1.68	2	1,020	3,410
STC 5			2.13	3		4,550
STC 7			3.03	5		6,820
STC 9		2,440	2.69	6	1,900	9,090
STC 14			3.69	10	2,980	13,640
STC 18		3,060	3.44	14		18,180
STC 23			4.04	18		22,730
STC 27		3,600	3.84	20	4,290	27,270

Note: *Depths are approximate.
Larger inlet pipe diameters can be accommodated - contact Humes for further information.

Variants

Continual improvement over the last 15 years of HumeCeptor® systems installation has provided a number of enhancements to address specific treatment and design requirements.

- **HumeCeptor® STC 2 (inlet) model**
  This model features a grated inlet to directly capture runoff from hardstand areas, replacing the need for a stormwater pit (refer to Figure 4).
- **AquaCeptor™ model**
  This model, available in the same sizes as standard HumeCeptor® units, has been designed with a weir extension and high level secondary inlet to increase the level at which flows bypass the treatment chamber, and accommodate downstream tail water levels or periodic inundation e.g. tidal situations (refer to Figure 5).
- **MultiCeptor™ model**
  The MultiCeptor™ model was developed to facilitate the replacement of junction pits while still providing the treatment abilities of the original HumeCeptor® system. Available in the same sizes as the standard HumeCeptor® units (refer Table 6 below) with the addition of a 2,440 mm diameter unit to accommodate drainage networks up to 1,800 mm diameter.

Figure 4 – HumeCeptor® STC 2 (inlet) model

Figure 5 – AquaCeptor™ model

Table 6 – MultiCeptor™ model range and details

HumeCeptor® model	Pipe diameter (mm)	Device diameter (mm)	Depth from pipe invert (m)	Sediment capacity (m^3)	Oil capacity (l)	Total storage capacity (l)
MI3	100 - 1,350	1,800	1.68	2	1,020	3,410
MI5			2.13	3		4,550
MI7			3.03	5		6,820
MI9		2,440	2.69	6	1,900	9,090
MI14			3.69	10	2,980	13,640
MI18		3,060	3.44	14		18,180
MI23			4.04	18		22,730
MI27		3,600	3.84	20	4,290	27,270
MI9 - MI27 (2,440)	100 - 1,800	2,440 top up to 3,600 base	2.69 - 3.84	6 - 20	1,900 - 4,290	9,090 - 27,270

- **DuoCeptor™ model**
  The DuoCeptor™ model has been developed to treat larger catchments (2 Ha – 6 Ha) as some constrained developments can only accommodate a single, large device instead of several smaller devices. Figure 6 displays the DuoCeptor™ model and Table 7 details the range of capacities available.

- **HumeCeptor EOS™ model**
  The HumeCeptor EOS™ (Emergency Oil Spill) system provides you with the maximum protection against hydrocarbon spills at petrol stations, highway interchanges and intersections. It combines the passive, always-operating functions of the HumeCeptor® system, with additional emergency storage to capture the volume of spill required by your road authority.

- **HumeCeptor MAX™ model**
  The HumeCeptor MAX™ model was developed to meet the market need for a single, large, end-of-pipe solution for TSS removal. Utilising the HumeCeptor® system's proven capture and scour prevention technology, it is ideal for very large commercial and industrial sites (>6 Ha) that need to achieve at least 50% TSS removal and hydrocarbon capture. The HumeCeptor MAX™ model can be expanded to almost any capacity required.

Figure 6 – DuoCeptor™ model

For more details on the variants and their application refer to the HumeCeptor® system technical manual.

Table 7 – DuoCeptor™ model range and details

DuoCeptor™ model	Pipe diameter (mm)	Device footprint (L x W)	Depth from pipe invert (m)	Sediment capacity (m^3)	Oil capacity (l)	Total storage capacity (l)
STC 40	600 - 1,500	7,750 x 3,500	3.41	27	10,585	42,370
STC 50			4.01	35	10,585	50,525
STC 60		9,150 x 4,200	3.89	42	11,560	60,255

Design information

To design a system suitable for your project it is necessary to review the configuration of the stormwater system, the location and purpose of other stormwater management (WSUD) controls, the catchment area and the hydrology. Refer to the HumeCeptor® system technical manual for further details.

MUSIC/pollutant export model inputs

Many local authorities utilise MUSIC or other pollutant export models to assist in stormwater treatment train selection, and recommend generic inputs for GPTs and hydrodynamic separators.

Considering these against the independent research results, and PCSWMM modelling used to size a HumeCeptor® unit, the following conservative removal efficiencies (refer to Table 8) are recommended on an annual basis (i.e. no bypass).

Table 8 – MUSIC inputs for the HumeCeptor® system

Pollutant	Removal efficiency
TSS	80%
TN	30%
TP	30%

Installation

Installation procedures

The installation of the HumeCeptor® unit should conform in general to local authority's specifications for stormwater pit construction. Detailed installation instructions are dispatched with each unit.

Construction sequence

The HumeCeptor® unit is installed in sections as follows:

1. Prepare the geotextile and aggregate base.
2. Install the treatment chamber base section.
3. Install the treatment chamber section/s (if required).
4. Prepare the transition slab (if required).
5. Install the bypass chamber section.
6. Fit the inlet drop pipe and decant pipe (if required).
7. Connect inlet and outlet pipes as required.
8. Prepare the transition slab.
9. Install the maintenance access chamber section. (if required).
10. Install the frame and access cover/grate.

Maintenance

The design of the HumeCeptor® system means that maintenance is generally conducted with a vacuum truck which avoids entry into the unit.

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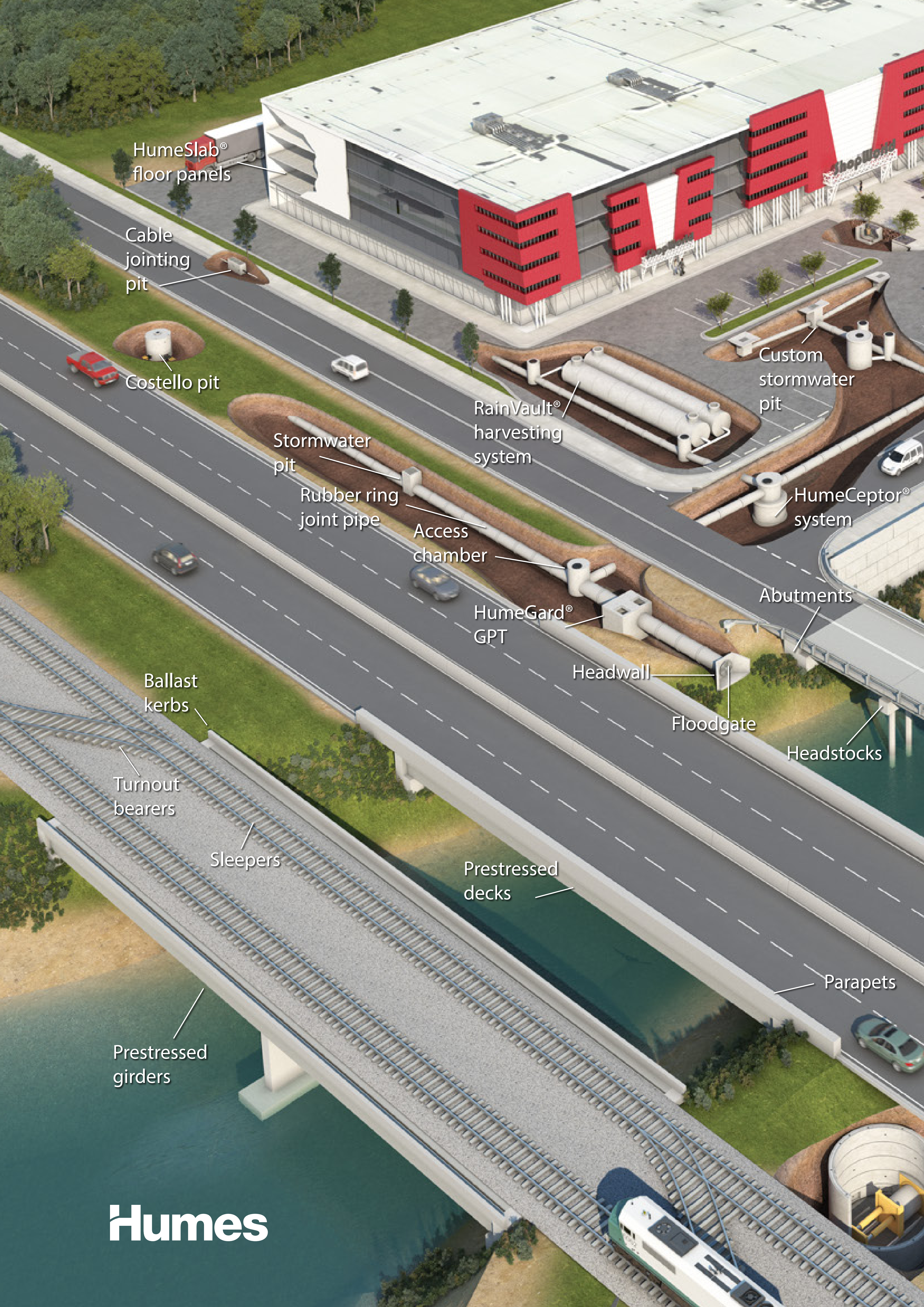
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Costello pit
Custom stormwater pit
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Stormwater pit
Rubber ring joint pipe
Access chamber
HumeCeptor® system
HumeGard® GPT
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HumeDeck® modular bridge
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Supabowl® precast base
Access chamber
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