Espey Consultants, Inc.

Data Collection Summary Report

WATER QUALITY CONTROL TECHNOLOGIES INVENTORY

City of Austin

July 2004

FAO No. 4850-617-6210/S020340
COA Project No. 5789.017

EC Project No. 2028.102

WATER QUALITY CONTROL TECHNOLOGIES INVENTORY:
Data Collection Summary Report

This report has been prepared with consideration for retrofit applications and the integration of water quality controls with proposed storm drain improvements in the Rosedale and Ridgelea neighborhood.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Municipalities have traditionally turned to non-proprietary technologies such as water quality ponds or vegetative filter strips to treat stormwater runoff, and it is required of most new developments. However, with the continued commitment of the City of Austin to further enhance and exceed required water quality standards in their local creeks, the City continues to seek retrofitting opportunities in highly concentrated urban developments. This need in Austin as well as other parts of the United States has resulted in a new era of water quality control technologies, both proprietary and non-proprietary, that can be implemented in both existing and new development areas. Today, the challenge encountered by municipalities is not deciding *if* a water quality system can be incorporated into a system, but is instead choosing which one best compliments the site constraints.

In this report, performance information pertaining to non-proprietary as well as proprietary water quality control technologies has been compiled and reviewed primarily with retrofit applications in mind for a residential neighborhood: Rosedale and Ridgelea. Storm drain upgrades currently proposed by the City of Austin in the Rosedale and Ridgelea neighborhood provide an opportunity for the integration of water quality controls. This study includes a review and screening of available technologies in order to identify viable solutions for consideration in preliminary engineering studies for application in the Rosedale and Ridgelea neighborhood.

Information presented in this report is broken down by:

1) A system's targeted pollutants and pollutant removal efficiency,
2) Its maintenance requirements and cost, and
3) The product history and special needs.

Pollutant removal efficiencies for several urban pollutants are included. However, since complete performance data is not readily available for all pollutants, the reported removal efficiencies for total suspended solids (TSS) are used as the primary point of comparison. Furthermore, in the final comparison between selected products, discernment between finer and coarser sediment is made. Maintenance and cost information is estimated and does not take into consideration specific site constraints, land acquisition costs or variations in model sizes available from each manufacturer. The product history and special needs inventory summarizes the documented performance of a technology, agency approvals, and special equipment or skilled personnel needed to maintain the system. Information regarding non-proprietary systems is obtained from published data, while proprietary product information is primarily based on data provided by the manufacturers. Water quality control technology research is limited to non-proprietary systems commonly used in the Austin area and proprietary products that had information readily available during the period of data collection.

The following table briefly summaries the results of the data collection effort conducted as part of this study. The first two columns of information included for proprietary technologies reflect the number of systems researched as part of this study and the number of systems that ranked highest in their individual categories. The highest ranked systems in each category represent a

short list of products used to complete the remaining columns presented in the table. For example, 2 out of 7 constructed inlet devices have performance standards or features that distinguish them from the others in that category. The information provided in the remaining columns is based on values given for those 2 products.

Table ES-1 - Summary Table

				Drainage Area Limit				
	# eval.	short listed	TSS removal efficiency (%)	< 1 ac	1-10 ac	10-25 ac	> 25 ac	maintenace requirements*
Non-Proprietary Technologies								
Baffle boxes[2]			70		*	*	*	
Vegetative Filter Strips[3]			85		*			
Infiltration/exfiltration trenches[4]			90		*			
Extended Detention Ponds[3]			75			*	*	
Wet Detention Ponds[3]			93			*	*	
Sedimentation / Filtration Systems[3]			89		*			
Vegetated/Grassy Swales[3]			70	*	*			
Constructed wetlands[3]			93			*	*	
Bioretention ponds[5]			90	*				
Retention/Irrigation Systems[3]			100			*	*	
Proprietary Technologies								
Bio-Retention	1	1	90	*				minimal
Inlet (constructed)	7	2	80		*	*	*	1 per year
Inlet Inserts	19	2	80-90		*	*		1-2 per year
Pipe Inserts	1	1	trash and debris		*	*		1-2 per year
Porous Pavements	3	2	95		*			minimal
Sedimentation/Filtration Chambers	10	4	60-92		*	*		1 per year

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001

2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004

3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999

4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999

5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003

* Maintenance requirements listed range from minimal to a frequency of maintenance to be performed on an annual basis. Minimal indicates that only mowing, pruning or debris pick-up is performed as needed or as desired.

This research and the results of this study are used in the preliminary engineering study of a specific retrofit application and the integration with proposed storm drain improvements in the Rosedale and Ridgelea neighborhood. The results of that study are bound separately.

1.0 INTRODUCTION

Water quality control devices are not a phenomenon of the 20th century. The first documented sand filter was constructed in 1829 to treat the Thames River in London, England (ASCE 2001). However, since 1948 when the Water Pollution Control Act became the first formal water quality legislation in the United States, this form of technology has become a rising issue as well as a specialized form of science and engineering. The City of Austin has been perfecting water quality control devices for over 20 years, and, within the past 5 to 10 years a new era of best management practices (BMPs) has arisen in order to help municipalities further enhance water quality in retrofit applications. Today, with the wide assortment of both traditional (typically non-proprietary) and proprietary pollutant removal systems available, municipalities are no longer required to independently design water quality controls. However, determining which systems will most complement the application and environmental parameters of a specific location is equally as challenging.

1.1 PURPOSE OF THE STUDY

The objectives of this study are to:

1) Research and compare non-proprietary, as well as, proprietary water quality control technologies and generate an inventory of collected information; and

2) Summarize the technologies for future application.

1.2 LIMITATIONS OF THE STUDY

This study includes the following limitations:

1) Available product literature is the only source of data for proprietary systems when manufacturers did not respond to the survey prepared by EC.
2) The primary list of manufacturers was obtained from: a.) participants of StormCon 2003: the North American Surface Water Quality Conference & Exposition held in July 2003 in San Antonio, Texas; b.) Environmental Technology Verification Program (ETV) applicants (sponsored by the US Environmental Protection Agency); and c.) products found through research over the internet.
3) Sufficient information was not readily available from users of the proprietary water quality control technologies to be included in inventory tables.
4) This study does not include detailed cost estimates. Cost and performance information is based on general constraints. Further research must be conducted to evaluate specific site constraints and associated project costs.
5) The screening process is primarily performed with consideration for the integration of water quality controls with proposed storm drain upgrades proposed in the Rosedale and Ridgelea neighborhood. The screening process may yield different results if performed for selecting a control with different site constraints and treatment objectives.

1.3 WATER QUALITY SYSTEMS AND INVENTORY CATEGORIES

The following types of system categories are reviewed in this study and are included in the inventory:

Table 1 - Water Quality System Categories

Non-Proprietary	Proprietary Technologies
baffle boxes	bio-retention
vegetative filter strips	inlet (constructed)[1]
infiltration/exfiltration trenches	inlet inserts[2]
extended detention ponds	pipe inserts
wet detention ponds	porous pavements
sedimentation/filtration systems	sedimentation and/or filtration chambers
vegetated swales	
constructed wetlands	
bio-retention ponds	
retention/irrigation	

[1] Products that replace or require modifications to existing inlets.
[2] Products that can be inserted into existing inlets without incurring any form of reconstruction of the existing inlet.

With respect to the first objective of this study, the pollutant capture efficiency, initial cost, installation cost, typical treatment area, history, testing, agency approvals and ability to retrofit are tabulated. Other measures of performance are considered as well, such as typical applications, special construction or maintenance needs, etc. With respect to the second objective of this study, the information is categorized and sorted in order to simplify a review of the technologies, given specific site constraints.

2.0 WATER QUALITY METHODS AND SYSTEMS

Information gathered for both traditional non-proprietary and manufactured, proprietary, water quality systems is included in the supplemental resource guides entitled: Water Quality Control Technologies Inventory: Literature/Product Research, Volumes 1 and 2. The following section briefly describes each category of systems included in this study.

2.1 NON-PROPRIETARY TECHNOLOGIES

Ten (10) primary forms of traditional non-proprietary technologies are included:

- Baffle boxes,
- Vegetative filter strips,
- Infiltration/exfiltration trenches,
- Extended detention ponds,
- Wet detention ponds,
- Sedimentation/filtration systems,
- Vegetated swales,
- Constructed wetlands,
- Bio-retention ponds, and
- Retention/Irrigation.

Other pond systems successfully used in other parts of the country include off-line and on-line retention ponds that rely on percolation through the natural soil in the bottom of the pond for treatment, and wet detention ponds with under-drain filtration systems. These systems are not typically used in the Austin area due to site constraints such as soil type, runoff yield and regulations associated with development over the Edwards Aquifer.

2.1.1 Baffle Boxes

Baffle boxes are subsurface units often used at the end of storm drain systems when space is not readily available for a pond. They require maintenance one to three times a year and pollutants must be removed with a vacuum truck. Baffle boxes can easily be placed in a retrofit application with limited right of way constraints. Although they require excavation in order to set the units in place, they can treat a relatively large drainage area, and the unit can be housed underground. The device is typically divided into three chambers separated by weir walls or baffles. Pollutants settle out in the chambers as stormwater passes through the system. Figure 1 illustrates the concept of a baffle box system.

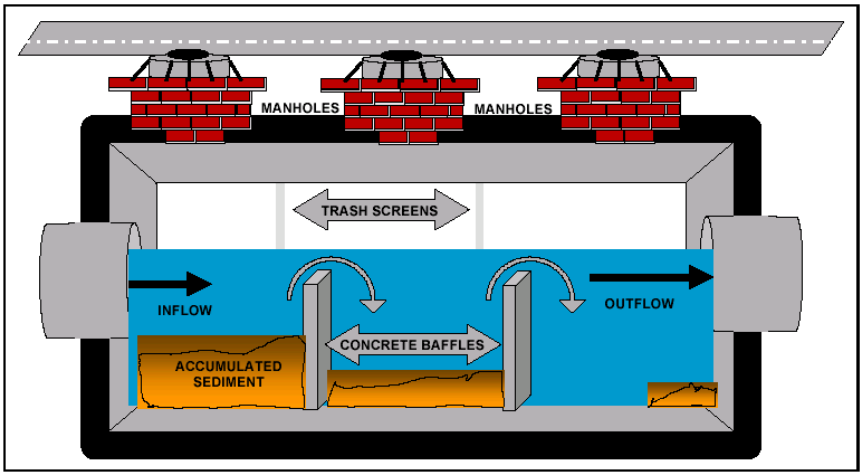

Figure 1 - Schematic of a Baffle Box

2.1.2 Vegetative Filter Strips

Vegetative filter strips reduce the velocity of the runoff, spread the water into a uniform sheet flow pattern and remove pollutants through infiltration into the soil and filtration by the vegetation. They require low maintenance and provide aesthetic value to the neighborhood. However, vegetative filter strips require significant amounts of land dedication. This method may also require high amounts of watering initially to establish the vegetation. Since buffer strips containing forest vegetation are required to achieve a higher level of TSS removal, a higher cost is proportionally incurred. Design criteria was adopted in early 2004 in the City of Austin's Environmental Criteria Manual (ECM) and it is an accepted practice by other regulatory agencies in the area. Figure 2 illustrate a vegetative filter strip adjacent to a highway.

Figure 2 - Vegetative Filter Strip Adjacent to Roadway

2.1.3 Infiltration/Exfiltration Trenches

Infiltration/exfiltration trenches are long narrow trenches that include a rock and soil filter media and/or a specialized filter fabric and can reduce fine sediment from stormwater runoff (Figure 3). These systems typically require a maintenance frequency of one to two times a year and should

include pre-treatment methods (e. g. vegetative filter strips, swales or detention/sedimentation basin) to reduce the coarse sediment load.

Figure 3 - Infiltration Trench

Although infiltration/exfiltration trenches do not require significant land dedication they are not effective in soils with high clay content and not recommended over groundwater recharge zones. This would further restrict the application of this technology in areas located directly over the Edward's Aquifer Recharge Zone. However, under-drain pipes could be incorporated to collect the filtered runoff and direct the discharge to an appropriate location. These systems are best applied when used in conjunction with a detention pond or other form of peak flow regulation since the trenches are not capable of conveying and/or treating peak flow rates.

2.1.4 Extended Detention Ponds

Extended detention ponds (Figure 4) do not include a filtration system but instead rely on the sedimentation of coarse particles through the regulation of the pond's release rate over an extended period of time (72 hours). Furthermore, by reducing the peak discharge rate from the watershed, the potential for downstream bank erosion can be reduced from frequent "bank forming" storm events. Although TSS removal is relatively high in this form of water quality control technology, other constituents may receive very little treatment. Figure 4 shows an extended detention pond constructed as part of a development located in the Hill Country west of Austin, Texas.

Figure 4 - Extended Detention Pond

2.1.5 Wet Detention Ponds

Figure 5 - Wet Detention Pond

Wet detention ponds are the most common form of pond in the United States and are commonly used in the greater Austin area. Although a relatively high level of TSS removal may be achieved, this system requires significant land dedication. The pond must also be able to maintain a permanent body of water; therefore, careful consideration of the system's water budget must be calculated in order to determine the viability of a wet detention pond at a particular site. As well as providing water quality treatment, this type of system creates an aesthetically pleasing feature and/or environmental/recreational area. Figure 5 shows a wet detention pond located along US Highway 290 in Austin, Texas.

2.1.6 Sedimentation/Filtration Systems

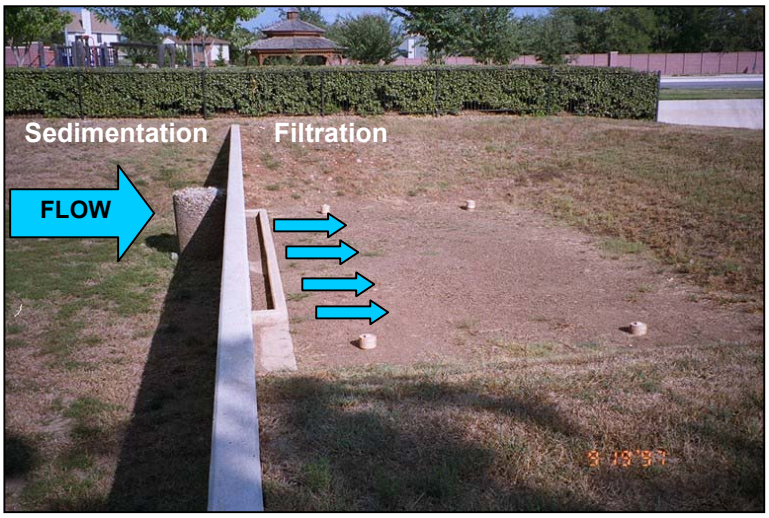

Figure 6 - Sedimentation/Filtration Pond

The current City of Austin Environmental Criteria Manual (ECM) includes sedimentation/ filtration systems as the primary water quality control device. These systems are commonly used for new development because they can treat runoff from areas with high levels of impervious cover, and can be constructed in confined spaces through the use of concrete walls instead of earthen embankments. These systems can include either full sedimentation of the water quality volume or partial sedimentation of the water quality volume, and both include post sediment treatment by use of a sand filter media. The filter media includes an under drain system that collects the treated runoff and discharges to a downstream location. These systems have a high TSS removal efficiency and require annual maintenance. Figure 6 illustrates the primary configuration and flow path of sedimentation/filtration ponds commonly used in Austin, Texas.

2.1.7 Vegetated Swales

Vegetated swales are often used as an alternative to curb and gutter systems along roadways. This method provides aesthetic value as well as functional water quality control. This system is effective in removing TSS and oil and grease from runoff. Minimal maintenance is required such as lawn care, debris removal, reseeding or mulching.

However, vegetated swales are difficult to install in a densely populated or commercial retrofit application and require sufficient soil and rainfall to support vegetation. Special consideration in the selection of vegetation should be taken to ensure that the flora would thrive given local environmental constraints, thus minimizing the cost of maintenance.

2.1.8 Constructed Wetlands

Constructed wetlands utilize physical and biological processes, including absorption, filtration, plant uptake, sedimentation, etc. to reduce pollutant loads in stormwater runoff. This system is effective in reducing TSS as well as other constituents. The price of this system and the maintenance it requires widely fluctuates. Initially the system must be inspected monthly until vegetation is established. After this point, inspection and removal of nuisance species should occur once a year.

Constructed wetlands require significant land dedication. Research has also shown that this method may not be effective in Austin, Texas due to limited rainfall and high rates of evapotranspiration.

2.1.9 Bio-Retention Ponds

Bio-Retention pond systems have been in use in the United States since the early 1990's. These systems use physical, biological and chemical processes to remove pollutants by retaining runoff in a ponding area and allowing water to be absorbed into the soil and plants. Water is distributed evenly throughout the pond area at a relatively shallow depth and is allowed to exfiltrate the pond over a period of days.

Figure 7 - Bio-Retention System

The use of vegetation in these systems gives a natural appearance and may provide some noise absorption. However, this system is not recommended for areas with steep slopes, and treats relatively small drainage areas (e. g. 0.25 acres to 1.0 acres).

2.1.10 Retention/Irrigation Systems

The retention of the initial runoff from storm events and the irrigation of that volume of water is a highly effective method of removing pollutants from the system. The irrigation of the runoff is applied to the appropriate landscape to maintain vegetation, and may also contribute to the recharge of aquifers. A significant amount of land area is required for irrigation fields to ensure that the application rate does not exceed the available infiltration rate of the soil. An adequate depth of soil is required to ensure treatment of irrigated water. Irrigation fields also require relatively flat slopes to inhibit runoff potential.

2.2 PROPRIETARY TECHNOLOGIES

Many proprietary technologies provide alternatives to the traditional techniques for new construction, while others primarily have uses in difficult retrofit applications. As part of this study questionnaires were developed and distributed to a wide range of water quality product manufacturers and users. The manufacturer and user questionnaire forms are included in Appendix A. Information from over forty different manufactured water quality systems is included in this inventory. Contact information for each proprietary system representative is documented in Appendix B, Table B-1. These products fall into five primary categories:

- bio-retention,
- inlet (constructed),
- inlet inserts,
- pipe inserts, and
- sedimentation and/or filtration chambers.

Each product is researched to determine its advertised pollutant capture efficiency, average unit price, installation cost, typical treatment area, history, testing, agency approvals and ability to retrofit as well as other measures of performance. The following paragraphs give a brief description for each category.

2.2.1 Bio-Retention Systems

Proprietary bio-retention systems, similar to non-proprietary bio-retention ponds, combine natural plant and soil filtration to provide treatment of stormwater runoff. The Filterra Stormwater Bio-retention Filtration System by Americast is the only proprietary product identified in this category.

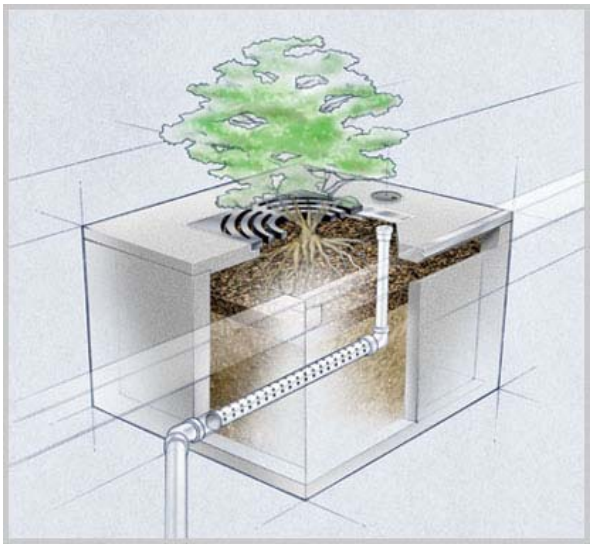

Figure 8 - Filterra Stormwater Bio-retention Filtration System by Americast

The Filterra System is included since information is readily available and the unit has a small commercial business application. These units are both aesthetically pleasing and highly efficient. Bio-retention systems are easily

applied to a retrofit application since they can be confined to small areas. Each Filterra unit occupies an area of 36 square feet. However, these units only treat a small area (0.25 acres per unit) and should probably be considered primarily in commercial areas where the pollutant load is highly concentrated in order to perform most efficiently.

The manufacturer includes a standard 2-year maintenance agreement and maintains records during that period. Maintenance typically includes removal of floatable debris that accumulates inside the device on the soil surface.

2.2.2 Constructed Inlets

Constructed inlets include filter systems housed inside specially designed inlet units to capture pollutant loads and require significant modifications to or reconstruction of existing inlets. Depending on the type of filter used in the system, oil and grease can also be captured. Seven proprietary systems are included in this category.

Constructed inlets can easily be applied to a retrofit project since the area needed for construction may be confined to the area of the existing inlet unit. However, when site constraints allow, larger units may be used to treat several inlets. These specialized units can easily be maintained with a vacuum truck and provide relatively high levels of pollutant removal.

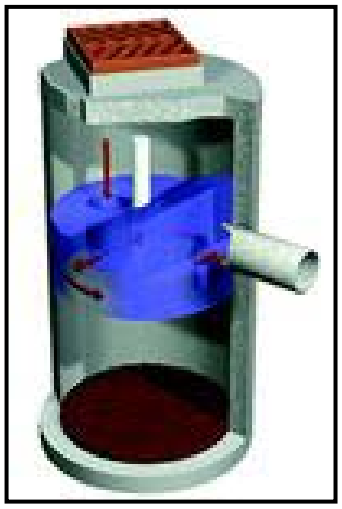

Figure 9 - The Stormceptor System by Rinker (Hydro Conduit)

2.2.3 Inlet Inserts

Inlet inserts are specialized devices that can be easily inserted in existing storm drain inlets without requiring modification or removal of the existing structure. These systems work especially well in retrofit applications because they are relatively inexpensive and can be designed to target specific pollutants. They are best applied on a temporary basis or when frequent maintenance is not a concern. Typically this type of product is used to collect trash and debris from the system. However, according to manufacturer literature, these units can also achieve effective removal of TSS and can capture oil and grease with the use of special inserts. Replacement filters must be ordered from the manufacturer and some manufacturers require the client to sign a service agreement further binding the client to the manufacturer. Literature on nineteen (19) products is included in this category.

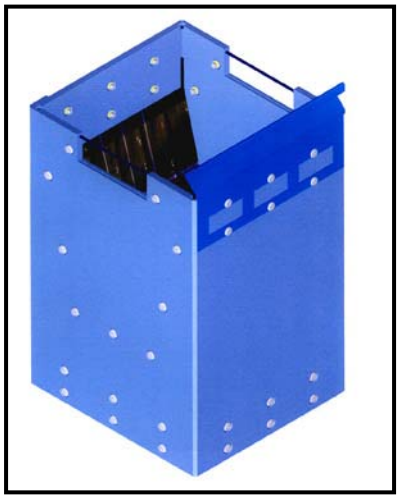

Figure 10 - Ultra-Urban Filter-Curb Opening Module-Normal Size by AbTech Industries, Inc.

2.2.4 Pipe Inserts

Pipe inserts are similar to inlet inserts in that they utilize specialized screens to capture targeted pollutants. However, pipe inserts require the construction

of a vault and an access door into the pipe so that the insert can be cleaned. The Storm Flo Litter Collection Screen by Roscoe Moss Co. is the only product of this type identified. It appears to be effective in reducing larger particles from stormwater runoff; however, its ability to remove fine particles or dissolved constituents is questionable. In order to rid the system of collected debris, maintenance crews are required to enter the unit and physically shovel the material out of the system. This can incur major costs for maintenance. This system must be properly maintained to prevent surcharge conditions and possible flooding.

Figure 11 - Storm Flo Litter Collection Screen by the Roscoe Moss Company

2.2.5 Porous Paving Systems

Porous paving systems are specially designed paving units that encourage the infiltration of water through the paved surface. This flow can either exfiltrate the underlying soil or can be collected by a perforated sub-surface pipe and carried from the site. These systems are extremely efficient at achieving targeted removal efficiencies for TSS. Three products are included in the inventory.

Figure 12 - Grasspave by Invisible Structures, Inc.

Porous paving systems require a large dedication of land and incur relatively large limits of construction. Although they work extremely well, these systems have a greater impact in large industrial or commercial parking lot areas. Many of these systems are intended for special uses: fire lanes, special event-based parking. They are typically not recommended for regular traffic uses such as residential streets. Little emphases is given to porous pavements in this study because the application is not a viable option in the Rosedale and Ridgelea neighborhood.

2.2.6 Sedimentation and/or Filtration Chambers

Sedimentation and/or filtration chambers are specially designed, on-line or off-line water quality treatment facilities that may contain a series of sediment chambers, baffles, screens and/or filter devices that target specific pollutants. These systems are typically contained underground in vaults and can be accessed through doors or manholes. These units can reportedly achieve high levels of TSS removal and typically require maintenance as little as once a year. Depending on the type of system, oil and grease may also be effectively removed.

Sedimentation and/or filtration chambers may be applied to retrofit projects with a relatively minor amount of reconstruction. However, larger drainage areas may require much larger areas for construction and may results in a more significant area of disturbance. They perform most cost effectively along a main collector storm drain system where they can serve larger drainage areas.

3.0 INVENTORY SUMMARY

An inventory of the various systems, as seen in Tables B-1 through B-4 in Appendix B, is compiled for comparison of the performance of each system by category. The inventory is divided into four tables entitled: Contact Information, Pollutant Removal Efficiencies, Maintenance and Cost Information and Product History and Special Needs. Table B-1 in Appendix B lists contact information for manufacturer representatives associated with each proprietary system. The remaining categories of information presented in Tables B-2, B-3 and B-4 are further explained in the following sections.

3.1 POLLUTANT REMOVAL

Table B-2 includes a list of the targeted materials (pollutants) captured, the application, and the reported pollutant removal efficiencies for each water quality system. When available, unique notes are included regarding primary materials captured (e. g. oil and grease, debris, etc.) and the application (e. g. commercial, industrial, etc.). The following list of pollutants is included in the inventory:

- Total Suspended Solids (TSS)
- Total Phosphorus (TP)
- Total Nitrogen (TN)
- Chemical Oxygen Demand (COD)
- Biochemical Oxygen Demand (BOD)
- Total Lead (Pb)
- Fecal Coliform (FC)
- Fecal Streptococci (FS)
- Total Organic Carbon (TOC)
- Total Petroleum Hydrocarbons (TPH)
- Oil and Grease (OG)
- Zinc (Zn)

The above list includes the pollutants typically found in urban runoff; however, some manufacturers reported other pollutants including copper, ammonia, etc. When reported, other pollutants are included in the inventory with the heading "other 1" and "other 2." Figure 13 presents the structure of the table. The complete inventory is included in Appendix B.

Water Quality Control Technologies Inventory
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2

Product/Manufacturer	Target Mat. Captured	Application	TSS	TP	TN	Pb	OG	Zn	other 1	other 2
Krhovjak 9000 Filtration System	trash, debris, etc.	commercial	100%	20%-30%	0	0	50%-90%	0	60% Cu	

Figure 13 - Example Removal Efficiency Matrix

3.2 MAINTENANCE AND COST INFORMATION

This inventory details various factors related to maintenance and cost. Figure 14 presents the structure of the cost inventory. Column descriptions are included below. The complete inventory is included as Table B-3 of Appendix B.

Water Quality Control Technologies Inventory — **Table B-3**
Data Collection Summary
Maintenance and Cost Information

Technology/Manufacturer	Maintenance Events (Times/Year)	Cost (Materials)	Cost (Installation)	Typ. Treatment Area (Acres)	Construction Area
Krhovjak 9000 Filtration System	2	$2,000	$500	2	10 ft^2

Figure 14 - Example Cost Matrix

Maintenance Events list the estimated number of maintenance events anticipated per year per unit. Since labor and equipment costs are associated with each maintenance event, this category is directly related to cost.

Cost (Materials) includes the estimated cost of materials incurred when purchasing one unit. This cost does not include land acquisition, installation or modifications to the existing system.

Cost (Installation) takes into consideration the cost of installing the technology into a hypothetical system. Therefore, this category does not include costs associated with land acquisition, removal of existing inlets or existing system modifications. The estimated costs are provided by the manufacturer's representative or documented publications and are therefore not site specific.

Typical Treatment Area is based on the approximate number of acres the system is capable of treating. A wide range of treatment areas may not be completely indicative of the nature of the water quality system. This range may be the result of a large system, capable of treating a large area, or it may indicate that a group of systems, when constructed in series, are capable of treating the large area.

Construction Area estimates the approximate footprint of construction in order to install a typical unit. This estimate does not take into account utility conflicts or other site-specific constraints.

3.3 HISTORY AND SPECIAL NEEDS

Product history and special needs summarizes the documented history and special provisions as they relate to each technology. Figure 15 presents the format of the History and Special Needs Inventory. Each column heading is described below. The complete inventory is included as Table B-4 of Appendix B.

Water Quality Control Technologies Inventory **Table B-4**
Data Collection Summary
Product History and Special Needs

Product/Manufacturer	Agency Approvals	1st installed	Cities	Reports, Case Studies, Manuals	Special Needs or Comments
Krhovjak 9000 Filtration System	EPA	1987	Denver, CO	"Performance," 1998.	Creates a confined space

Figure 15 - Example History Matrix

Agency Approvals lists regulatory agencies or municipalities that have approved and/or used a particular water quality control technology or product.

First Installed documents the first reported installation of the technology, not necessarily the first laboratory testing of the system.

Cities lists the locations of currently installed systems. Some technologies are installed in such a wide range of locations that only an abbreviated list is included in the inventory. For a complete list of documented installations, refer to the Literature/Product Information, Volumes 1 and 2.

Reports, Case Studies and Manuals contains the title and date of available technical documents/reports that are included in the Literature/Product Information, Volumes 1 and 2. Third party information is notated in the inventory.

Special Needs or Comments highlights special equipment, regulations or procedures that apply in the installation or maintenance of the technology. This section also denotes special considerations that might either prevent or further recommend the technology for application given the environmental parameters of Austin, Texas.

4.0 INVENTORY SCREENING

The following paragraphs summarize the evaluation of the inventory tables for both non-proprietary and proprietary technologies. The results presented for non-proprietary technologies are primarily based on published data. The results presented for proprietary technologies are based on a review of information provided by the manufacturers with respect to:

1) Pollutant removal efficiency (primarily TSS due to limited information available on other pollutants),
2) Maintenance requirements and cost, and
3) Performance history including agency approvals and special needs.

Figure 16 is a flow chart illustration of the screening process using these 3 primary evaluation criteria. It includes screening of products for each category (e. g. inlet inserts, pipe inserts, sedimentation and/or filtration chambers, etc.) in order to identify a distinguished group of products within that category that appear to meet the highest performance standards. The process uses the 3 evaluation criteria in the order list above and is somewhat subjective based on professional judgment and consideration of retrofit applications in the Rosedale and Ridgelea neighborhoods.

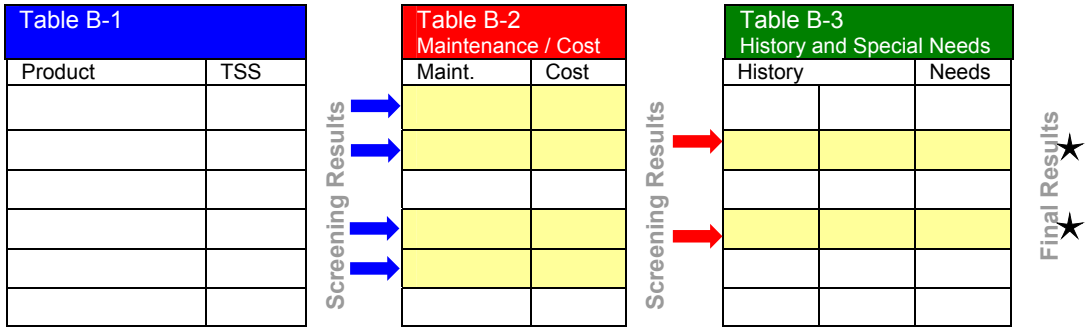

Figure 16 - Selection Process Flow Chart (Proprietary Technologies)

The highest ranked products in each category are considered in subsequent evaluation criteria screening. For example, initially 4 of the 7 constructed inlet devices are distinguished as having similar high pollutant removal efficiencies. Subsequently, 2 out of those 4 were distinguished as having lower maintenance cost requirements. And finally, those same 2 products had similar histories and/or special needs. These 2 products are said to be "short listed" in this category (★ denotes short list products). They are therefore recommended for consideration in a specific area when this type of device is warranted. Detailed water quality analysis, cost analysis and a review of specific site constraints is required of these 2 alternatives in a preliminary engineering design study.

While TSS is the primary constituent used in this initial screening process, this short list selection method could be revised to specifically consider other pollutants that might yield a different group of products for consideration in a specific application. TSS is used in this evaluation because it is the most common pollutant reported by manufacturers and is commonly referred to in performance for design standards for comparison.

4.1 NON-PROPRIETARY TECHNOLOGIES

The following paragraphs briefly describe the non-proprietary technologies included in this study and their local application.

Baffle boxes, infiltration/exfiltration trenches and bio-retention ponds are relatively new practices in the Austin area; however, they have advantages in both new and existing development applications. These systems require small to moderate amounts of land dedication and have relatively low maintenance requirements. Many manufacturers have developed baffle box designs that are discussed in the following section. They are probably more economical than non-proprietary alternative given the investment of time in the designs.

Constructed wetlands require significant land dedication, and due to limited rainfall and high rates of evapotranspiration, this method may not be an effective water quality technique in Austin, Texas.

The remaining six systems **(vegetative filter strips, extended detention ponds, wet detention ponds, sedimentation / filtration systems, vegetated / grassy swales and retention / irrigation systems)** are successfully used throughout the Austin area to comply with local and State development regulations; however, they are only applicable where land area is available.

4.2 PROPRIETARY TECHNOLOGIES

The following paragraphs include a summary of the proprietary technologies and the results of the screening process for consideration in local applications.

Bio-retention systems, both non-proprietary and proprietary, provide a very appealing water quality treatment alternative that can compliment the landscaping character of a development. The recommended treatment area size for this system appears to be a limiting factor in their application. The Filterra Stormwater Bio-retention Filtration System by Americast has a treatment area of up to 0.25 acres while it is recommended that constructed systems only serve up to 1 acre (CSWA 2003). In addition to removing TSS, these systems can also effectively reduce other constituents including TP, TN, Pb, TPH, OG and Zn. Bio-retention technology is being used more and more in the Austin area.

Based on the results of the screening process, the following **constructed inlet** devices have the best-reported performance out of the seven devices researched:

- Baysaver Separation System by BaySaver, Inc.; and
- Stormceptor System by Rinker (Hydro Conduit).

According to the reported data, these devices provide a TSS removal efficiency of up to 80% and oil and grease removal efficiency of 80 to 97%. Baysaver Separation System reports removal of a minimum particle size of 1.18 mm and Stormceptor System reports removal of a minimum particle size of 0.4 mm with a removal efficiency of 80%. These systems provide

limited removal of TP, TN, Pb, TPH and oil/grease. Maintenance of these devices is required annually, and these systems have been approved by various municipalities, departments of transportation (DOT), as well as other agencies.

Inlet inserts provide a quick retrofit solution that requires minimum construction effort. However, these devices are probably best suited for application when temporary solutions are required (e. g. construction). Two (2) of the nineteen devices included in this inventory research are reported to have the most effective pollutant removal efficiency, acceptable maintenance requirements and a documented history with other agencies. These systems include:

- Inceptor by Stormdrain Solutions, and
- Ultra-DrainGuard by Ultra Tech.

The manufacturers of these devices report a TSS removal efficiency of up to 80% (minimum particle size of 0.044 mm reported). The Interceptor reports significant removal efficiencies for COD, BOD, Pb, TPH, oil/grease and low removal efficiencies of TP and Zn. Removal efficiencies of 50% are reported for COD, BOD, Pb, TPH and Zn. Ultra-Drain Guard only reports a removal efficiency for one other pollutant: 70% for TPH.

Only one **pipe insert** device is included in this inventory. While advertised to have a TSS removal efficiency of 98%, this device primarily eliminates trash and debris from stormwater runoff and is not effective in removing finer particles. Field tests of this device began in 1999 in California and approval is pending with Caltrans.

Three (3) **porous pavement** products by Invisible Structures, Inc. are included in this inventory: Grasspave, Gravelpave and Rainstore. Two of these pavements report high TSS removal efficiencies of 95%. No other pollutants are reported and only very limited data is included for the remainder of the inventory categories. Porous pavements may provide benefits in certain applications; however, they require relatively flat slopes, large surface areas and do not allow constant traffic use. Limited or restricted use may be required to avoid compaction of sediment that may reduce the permeability of the material. Thatching is a common problem encountered when using grass as a filter media. Thatching results when layers of grass and sediment build up in cells. Porous paving systems require a large dedication of land and incur relatively large limits of construction. Although they work extremely well, these systems would have a greater impact in large industrial or commercial parking lot areas. Many of these systems are intended for special uses: fire lanes, special event-based parking. They are typically not recommended for regular traffic uses such as residential streets.

Four (4) of the ten (10) **sedimentation and/or filtration chamber** systems passed the screening process. These systems report relatively high rates of TSS removal efficiencies ranging from 60% to 92% (minimum particle sizes reported range from 0.05 mm to 0.07 mm), and removal of various other pollutants including TP, TN, COD, Pb, TOC, FC, TPH, oil/grease and Zn. These systems include:

- Aqua-Filter: Stormwater Filtration System by AquaShield (MKM Sales, Inc.),
- Storm Vault by Jensen Precast,

- StormFilter by Stormwater Management, Inc., and
- Vortechs System by Vortechnics, Inc.

Maintenance of these systems is performed once a year or less and the system may treat an area up to 25 acres. These systems have been approved by various local and state governmental agencies.

4.3 SUMMARY OF RESULTS

Table 2 includes a brief summary of the screening results for each treatment category. It provides general information including an estimated TSS removal efficiency for each category, drainage area limitations and maintenance requirements. It is not intended to be a complete and comprehensive summary, but an overview of the results of this study. More detailed engineering studies are required to select and size treatment methods for a particular area.

Table 2 - Summary Table

	# eval.	short listed	TSS removal efficiency (%)	Drainage Area Limit				maintenace requirements*
				< 1 ac	1-10 ac	10-25 ac	> 25 ac	
Non-Proprietary Technologies								
Baffle boxes[2]			70		*	*	*	
Vegetative Filter Strips[3]			85		*			
Infiltration/exfiltration trenches[4]			90		*			
Extended Detention Ponds[3]			75			*	*	
Wet Detention Ponds[3]			93			*	*	
Sedimentation / Filtration Systems[3]			89		*			
Vegetated/Grassy Swales[3]			70	*	*			
Constructed wetlands[3]			93			*	*	
Bioretention ponds[5]			90	*				
Retention/Irrigation Systems[3]			100			*	*	
Proprietary Technologies								
Bio-Retention	1	1	90	*				minimal
Inlet (constructed)	7	2	80		*	*	*	1 per year
Inlet Inserts	19	2	80-90		*	*		1-2 per year
Pipe Inserts	1	1	trash and debris		*	*		1-2 per year
Porous Pavements	3	2	95		*			minimal
Sedimentation/Filtration Chambers	10	4	60-92		*	*		1 per year

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001

2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004

3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999

4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999

5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003

* Maintenance requirements listed range from minimal to a frequency of maintenance to be performed on an annual basis. Minimal indicates that only mowing, pruning or debris pick-up is performed as needed or as desired.

5.0 REFERENCES

American Society of Civil Engineers (ASCE), "Guide for Best Management Practice (BMP) Selection in Urban Developed Areas," Urban Water Infrastructure Management Committee's Task Committee for Evaluating Best Management Practices, Reston, Virginia, 2001

City of Austin (COA), "Evaluation of Nonpoint Source Controls, an EPA/TNRCC Section 319 Grant Report, Volume 1, Final Report," December 1997

City of Austin (COA), "Environmental Design Criteria Manual," revisions through 2000

Georgia Stormwater Management Manual, "Alum Treatment System," 2001

England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004

Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999

U.S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999

California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003

Lower Colorado River Authority (LCRA), "LCRA NPS Technical Manual," 1998

APPENDIX A—QUESTIONNAIRE FORMS

City of Austin Water Quality Retrofit Project

Questionnaire for Manufacturers

Contact		**Product**	
Company			
Address			
		Website	
Phone		**E-Mail**	
Fax			

Pollutant (City of Austin SOS List) write in other pollutants captured	**Captured? check all that apply**	**Removal Efficiency (%)**
Total Suspended Solids (TSS)	☐	
Total Phosphorus (TP)	☐	
Total Nitrogen (TN)	☐	
Chemical Oxygen Demand (COD)	☐	
Biochemical Oxygen Demand (BOD)	☐	
Total Lead (Pb)	☐	
Fecal Coliform (FC)	☐	
Fecal Streptococci (FS)	☐	
Total Organic Carbon (TOC)	☐	
Total Petroleum Hydrocarbons	☐	
Oil and Grease	☐	
Zinc (Zn)	☐	
	☐	
	☐	

Maintenance Requirement (e.g. 4 times/year):

_____ **/year**

Pricing Information:

Cost (materials only)

_____

Cost (materials plus installation)

_____

Category: (check all that apply)

- ☐ Bio Retention
- ☐ Catch Basins
- ☐ Inlet Filter Inserts
- ☐ Sedimentation/Filtration Chambers
- ☐ Underground Sedimentation Tanks
- ☐ Other _____

What is the typical/recommended treatment drainage area? _____

List agency approvals (if applicable): _____

When and where was the product first installed? _____

What public or private entities have implemented this system (include client contact information)? _____

Is testing being conducted (include studies and/or references)? _____

Does this product require reconstruction of the existing system for installation to occur? _____

City of Austin Water Quality Retrofit Project

Questionnaire for Users

Contact		**Product**	
Company			
Address			
		Website	
Phone		**E-Mail**	
Fax			

Cost Information (if available):

Cost (materials only)

_____

Cost (materials plus installation)

_____

Application (check all that apply):

In what type of system was the product installed?

- ☐ Retrofit
- ☐ New Construction
- ☐ Residential
- ☐ Industrial
- ☐ Commercial

When was the product installed?

- ☐ 0-1 years
- ☐ 1-2 years
- ☐ 2-5 years
- ☐ > 5 years

Maintenance Experience:

service **/year**

Comments:

Satisfaction with product:

☐ Low ☐ Medium ☐ High

Comments:

APPENDIX B—DATA INVENTORY SUMMARIES

Water Quality Control Technologies
Data Collection Summary
Contact Information

Table B-1
July 1, 2004
EC Project No 2028.102

Response	Technology/Manufacturer	Sales Rep/Contact	Mailing Address	Phone	Fax	Website	E-mail
A	**BIO RETENTION**						
✓	Filterra Stormwater Bioretention Filtration System **Americast**	Terry Siviter	11352 Virginia Precast Rd. Ashland, VA 23005	804-798-6068	804-798-3426	www.filterra.com	tsiviter@filterra.com
B	**INLET (CONSTRUCTED)**						
✓	First Flush Cast in Place Filter Units **ABT, Inc.**	Bill Ousley	259 Murdock Troutman, NC 28166	800-438-6057	704-528-5478	www.abtdrains.com	billousley@abtdrains.com
✓	Aqua-Swirl: Stormwater Treatment System **AquaShield (MKM Sales, Inc.)**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.aquashieldinc.com	shea@mkmsales.com
✓	Baysaver Separation System **BaySaver, Inc.**	Hollis Tautenhahn	18067 Partidge Green Houston, TX 77084	281-856-9292 (office) 281-250-1940 (cell)	281-856-9292	www.baysaver.com	htautenhahn@baysaver.com
✓	Storm Water Treatment Unit (SWTU) **CDS Technologies**	Thomas L. Fletcher, P.E.	CDS Technologies, Inc. 6409 Oakmont Drive McKinney, Texas 75070	972-369-0290	972-369-0319	www.cdstech.com	tfletcher@cdstech.com
✓	V2B1/UNISTORM **Environment 21, LLC**	Michael F. Patterson	8713 Read Road East Pembroke, NY 14056	585-762-8314	585-762-8315	www.env21.com	envengr@env21.com
✓	Storm Trooper Stormwater Interceptors **Park Environmental Equipment**	Pat Schrum	7015 Fairbanks N. Houston Houston, TX 77040	800-256-8041	713-937-4254	www.storm-trooper.com	pschrum@park-usa.com
✓	The Stormceptor System **Rinker (Hydro Conduit)**	Kenneth E. Waite, P.E.	6560 Langfield Rd., Bldg. 3 Houston, TX 77092-1008	832-590-5405	832-590-5399	www.rinkerstormceptor.com	kwaite@rinker.com
C	**INLET INSERTS**						
✓	First Flush Inlet Inserts **ABT, Inc.**	Bill Ousley	259 Murdock Troutman, NC 28166	800-438-6057	704-528-5478	www.abtdrains.com	billousley@abtdrains.com
✓	Ultra-Urban Filter **AbTech Industries, Inc.**	Robert Liguori	4110 N. Scottsdale Rd. Scottsdale, AZ 85251	480-874-4000	480-970-1665	www.abtechindustries.com	rliguori@abtachindustries.com
✓	Aqua-Guard: Catch Basin Insert **AquaShield**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.aquashieldinc.com	shea@mkmsales.com
✓	The Snout: Oil-Water-Debris Separator **Best Management Products, Inc.**	T.J. Mullen	53 Mt. Archer Rd. Lyme, CT 06371-3130	800-504-8008	510-687-6757	www.bmpinc.com	tjm@bmpinc.com
	ClearWater BMP **Clearwater Solutions**	Stewart McClure		760-598-2545	760-598-1371	www.clearwaterbmp.com	stewart@clearwaterbmp.com tina@hartinc.cc
	DrainPac Stormwater Filtration **Drain Works**	Mike Sanchez		800-272-2832	255-683-8711	www.drainpac.com	mikesanchez@pactecinc.com
✓	Hydro-Kleen Filtration System **Hydrocompliance Management, Inc.**	David Woelkers	815 N. Second St., Suite 118 Brighton, MI 48116	800-526-9629 810-229-0123 734-216-7988 (cell)	810-225-7793	www.hydrocompliance.com	dwoelkers@HydroCompliance.com
	Downstream Defender **Hydro International**	David Mongeau		207-756-6200	207-756-6212	www.hiltech.com	dmongeau@hil-tech.com
✓	FloGard+Plus **KriStar Enterprises, Inc.**	Doug Allard	KriStar Enterprises, Inc. P.O. Box 7352 Santa Rosa, CA 95407	800-579-8819	707-524-8186	www.kristar.com	doug@kristar.com
✓	ecoSep high efficiency oil separation **Royal Environmental System**	John Stark	30622 Forest Blvd P.O. Box 119 Stacy, MN 55079	800-817-3240	651-462-6990	www.royalenterprises.net	jgs@royalenterprises.net
✓	ecoStop spill control technology **Royal Environmental System**	John Stark	30622 Forest Blvd P.O. Box 119 Stacy, MN 55079	800-817-3240	651-462-6990	www.royalenterprises.net	jgs@royalenterprises.net
✓	ecoStorm hydro-dynamic structural stormwater treatment technology **Royal Environmental System**	John Stark	30622 Forest Blvd P.O. Box 119 Stacy, MN 55079	800-817-3240	651-462-6990	www.royalenterprises.net	jgs@royalenterprises.net
✓	Inceptor **Stormdrain Solutions**	Michael Sharpless	333 Beaumont Rd Devon, PA 19333	877-687-7473	610-687-6327	www.stormdrains.com	mikes@stormdrains.com
✓	StormScreen **Stormwater Management, Inc.**	Scott Love	11421 Cherry Ridge Court Dallas, TX 75229	800-548-4667	214-357-6484	www.stormwaterinc.com	scottl@stormwaterinc.com
	Grate Inlet Skimmer Boxes **Suntree Technologies, Inc.**	Tom Happel		321-637-7552	321-637-7552	www.suntreetech.com	happel@suntreetech.com
	Curb Inlet Baskets **Suntree Technologies, Inc.**	Tom Happel		321-637-7552	321-637-7552	www.suntreetech.com	happel@suntreetech.com
✓	Ultra-DrainGuard **Ultra Tech**	Phyl Kimball	11542 Davis Creek Court Jacksonville, FL 32256	800-353-1611 ext. 211	904-292-1325	www.stormwater-products.com	phyl@stormwater-products.com

Water Quality Control Technologies
Data Collection Summary
Contact Information

Table B-1
July 1, 2004
EC Project No 2028.102

Response	Technology/Manufacturer	Sales Rep/Contact	Mailing Address	Phone	Fax	Website	E-mail
	Ultra-GrateGuard **Ultra Tech**	Phyl Kimball	11542 Davis Creek Court Jacksonville, FL 32256	800-353-1611 ext. 211	904-292-1325	www.stormwater-products.com	phyl@stormwater-products.com
	Ultra-CurbGuard **Ultra Tech**	Phyl Kimball	11542 Davis Creek Court Jacksonville, FL 32256	800-353-1611 ext. 211	904-292-1325	www.stormwater-products.com	phyl@stormwater-products.com
D	**PIPE INSERTS**						
✓	Storm Flo Litter Collection Screen **Roscoe Moss Co.**	Kevin McGillicuddy	4360 Worth Street Los Angeles, CA 90063	323-263-4111	363-263-4497	www.roscoemoss.com	mosswells@aol.com
E	**POROUS PAVEMENTS**						
✓	Grasspave **Invisible Structures, Inc.**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.invisiblestructures.com	shea@mkmsales.com
✓	Gravelpave **Invisible Structures, Inc.**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.invisiblestructures.com	shea@mkmsales.com
✓	Rainstore **Invisible Structures, Inc.**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.invisiblestructures.com	shea@mkmsales.com
F	**SEDIMENTATION AND/OR FILTRATION CHAMBERS**						
✓	Computer Controlled Cartridge Filtration System **AquaLogic**	John R. Roy	14093 Bulverde Rd San Antonio, TX 78247	210-402-3434	210-403-2607	www.aqualogic-usa.com	jroy@aqualogic-usa.com
✓	Aqua-Filter: Stormwater Filtration System **AquaShield (MKM Sales, Inc.)**	Mr. Shea Kent	MKM Sales, Inc. 72899 College Street (77707) P.O. Box 26012 (77720) Beaumont, TX	409-866-6702	409-866-6501	www.aquashieldinc.com	shea@mkmsales.com
	BioStorm Stormwater Treatment Systems **Bio-Microbics**	Brody Dorland		913-422-0707	913-422-0808	www.biomicrobics.com	bdorland@biomicrobics.com
✓	Water Quality Vault **CrystalStream Technologies**	Brad Crouch	11191 Westheimer, #222 Houston, TX 77042-3222	832-483-2014	770-979-6954	www.crystalstream.com	bradcrouch@crystalstream.com
	UI-SU-2215 HTC Oil/Water Separator **Highland Tank**	Thomas Schoendorf		631-473-0598	631-928-3379	www.highlandtank.com	tschoendorf@highlandtank.com
✓	Storm Vault **Jensen Precast**	Steven Phelps	625 Bergin Way Sparks, NV 89431	775-352-6329	775-359-6364	www.stormvault.com	sphelps@jensenprecast.com
✓	Oil-Water Separators **PS International, Inc.**	Gale Paulson	1013 Shenandoah Circle Sioux Falls, SD 57103	605-332-1885	605-332-1293	www.psinternational.com	galewp@sio.midco.net
✓	StormFilter **Stormwater Management, Inc.**	Scott Love	11421 Cherry Ridge Court Dallas, TX 75229	214-734-9109	214-357-6484	www.stormwaterinc.com	scottl@stormwaterinc.com
✓	StormGate Separator **Stormwater Management, Inc.**	Scott Love	11421 Cherry Ridge Court Dallas, TX 75229	214-734-9109	214-357-6484	www.stormwaterinc.com	scottl@stormwaterinc.com
✓	Vortechs System **Vortechnics, Inc.**	Amy Anzelc	6906 Riverton Drive Austin, TX 78729	512-331-6316	512-331-6349	www.vortechnics.com	aanzelc@vortechnics.com

Water Quality Control Technologies
Data Collection Summary
Contact Information

Table B-1
July 1, 2004
EC Project No 2028.102

Response	Technology/Manufacturer	Sales Rep/Contact	Mailing Address	Phone	Fax	Website	E-mail
G	**NON-PROPRIETARY**						
	Alum Treatment Systems[1]	--	--	--	--	--	--
	Baffle Boxes[2]	--	--	--	--	--	--
	Vegetative Filter Strips[3]	--	--	--	--	--	--
	Infiltration/Exfiltration Trenches[4]	--	--	--	--	--	--
	Extended Detention Ponds[3]	--	--	--	--	--	--
	Wet Detention Ponds[3]	--	--	--	--	--	--
	Sedimentation / Filtration Systems[3]	--	--	--	--	--	--
	Vegetated/Grassy Swales[3]	--	--	--	--	--	--
	Constructed Wetlands[3]	--	--	--	--	--	--
	Bioretention Ponds[5]	--	--	--	--	--	--
	Retention/Re-Irrigation Systems[3]	--	--	--	--	--	--

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001
2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004
3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999
4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999
5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003
6 Lower Colorado River Authority (LCRA), "LCRA NPS Technical Manual," 1998
7 American Society of Civil Engineers (ASCE), "A Guide for BMP Selection in Urban Developed Areas," 2001
8 City of Austin, "Environmental Criteria Manual," revisions through 2000
9 City of Austin, "Evaluation of Nonpoint Source Controls, an EPA/TNRCC Section 319 Grant Report, Volume 1, Final Report," December 1997

Water Quality Control Technologies
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2
July 1, 2004
EC Project No 2028.102

Technology/Manufacturer	Targeted Materials Captured	Application	TSS	TP	TN	COD	BOD	Pb	FC	FS	TOC	TPH	OG	Zn	other 1	other 2
BIO RETENTION																
Filterra Stormwater Bioretention Filtration System **Americast**	Trash, sediment, oil and grease	new or retrofit industrial, commercial, residential	90%	80%	60%	--	--	90%	--	--	--	80%	80%	90%	Cu 90%	--
INLET (CONSTRUCTED)																
First Flush Cast in Place Filter Units **ABT, Inc.**	oil and grease	--	Yes	--	--	Yes	--	--	--	--	Yes	Yes	Yes	--	--	--
Aqua-Swirl: Stormwater Treatment System **AquaShield (MKM Sales, Inc.)**	oil, debris	commercial	91%	--	--	--	--	--	--	--	--	--	100% Floatable	--	Floatable Debris	--
Baysaver Separation System **BaySaver, Inc.**	oil, trash and floatable debris, sediment	commercial, residential, industrial	80%	10-15%	--	--	--	--	--	--	--	80%	80%	--	--	--
Storm Water Treatment Unit (SWTU) **CDS Technologies**	sediments, gross debris, floatables, bouyant debris, oil and grease	municipal, commercial	80%	30%	--	--	--	--	--	--	--	--	40 to 70% 80 to 80% w/ oil sorbents	--	--	--
V2B1/UNISTORM **Environment 21, LLC**	debris, sediment, oil, organic debris	residential, municipal	5-10%	30-60%	--	--	--	30-60%	--	--	--	--	40-70%	50-70%	sandy sediment 65-85%	--
Storm Trooper Stormwater Interceptors **Park Environmental Equipment**	sand, oil and grease	residential, industrial	85.08% to 96.93%	--	--	--	--	--	--	--	--	98%	96%	--	--	--
The Stormceptor System **Rinker (Hydro Conduit)**	debris, TSS, oil, grease	residential	80%	17 to 32%	43 to 56%	--	--	35 to 55%	--	--	--	97%	97%	35 to 55%	--	--
INLET INSERTS																
First Flush Inlet Inserts **ABT, Inc.**	trash and debris	--	Yes	--	--	Yes	--	--	--	--	Yes	Yes	Yes	--	--	--
Ultra-Urban Filter **AbTech Industries, Inc.**	oil, grease, debris, sediment	industrial, municipal	40 to 80%	--	--	--	--	--	10 to 60%	10 to 60%	--	up to 90%	up to 90%	40%	Floatables/Trash & Debris retent of 90%	Oil Absorbent Tech for Hydro Seps up to 90%
Aqua-Guard: Catch Basin Insert **AquaShield**	debris, sediment	commercial	80%	40%	--	--	--	--	--	--	--	95%	100% Floatable	95%	Floatable Debris	--
The Snout: Oil-Water-Debris Separator **Best Management Products, Inc.**	debris, oil	residential	30 to 45%	up to 70%	up to 70%	up to 50%	up to 50%	up to 50%	--	--	--	up to 50%	up to 80%	up to 50%	--	--
ClearWater BMP **Clearwater Solutions**	trash, sediment, hydrocarbons, metals, nutrients	residential	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DrainPac Stormwater Filtration **Drain Works**	debris	residential, municipal, industrial	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydro-Kleen Filtration System **Hydrocompliance Management, Inc.**	hydrocarbons, organically bound metals, PCB's, pesticides, VOC's sulfides and other contaminants	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Downstream Defender **Hydro International**	sediment, oil, trash, debris, phosphorus, metals	residential, municipal, industrial, commercial	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SCREENING RESULTS

Water Quality Control Technologies
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2
July 1, 2004
EC Project No 2028.102

Technology/Manufacturer	Targeted Materials Captured	Application	TSS	TP	TN	COD	BOD	Pb	FC	FS	TOC	TPH	OG	Zn	other 1	other 2	
FloGard+Plus **KriStar Enterprises, Inc.**	vegetation, litter, debris, coarse sediments, petroleum hydrocarbons	residential, municipal	100% (>589 nm)	--	--	--	--	--	--	--	--	--	70 to 80%	--	--	--	
ecoSep high efficiency oil separation **Royal Environmental System**	--	residential, municipal, industrial, commercial	>= 30 microns	--	--	--	--	--	--	--	--	<5.0 ppm free oil	<5.0 ppm	--	--	--	
ecoStop spill control technology **Royal Environmental System**	--	residential, municipal, industrial, commercial	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
ecoStorm hydro-dynamic structural stormwater treatment technology **Royal Environmental System**	--	residential, municipal, industrial, commercial	80%	minimal if any	minimal if any	minimal if any	minimal if any	minimal if any	minimal if any	minimal if any	minimal if any	30 to 50%	--	--	--	--	
Inceptor **Stormdrain Solutions**	hydrocarbons, TSS, silt, sediment, particulate heavy metals, PCBs, floatables	residential	80%	23%	--	83%	73%	86%	--	--	--	98%	99%	13%	--	--	
StormScreen **Stormwater Management, Inc.**	--	commercial, industrial, residential	some	--	--	--	--	--	--	--	--	--	--	--	trash and debris 100%	oil and grease with absorbent hood cover	
Grate Inlet Skimmer Boxes **Suntree Technologies, Inc.**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Curb Inlet Baskets **Suntree Technologies, Inc.**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Ultra-DrainGuard **Ultra Tech**	trash, sediment	industrial, commercial	90%	--	--	--	--	--	--	--	--	70%	--	--	--	--	
Ultra-GrateGuard **Ultra Tech**	sediment, oil	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Ultra-CurbGuard **Ultra Tech**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
PIPE INSERTS																	
Storm Flo Litter Collection Screen **Roscoe Moss Co.**	trash and debris, suspended solids	industrial, commercial	98%	--	--	--	--	--	--	--	--	--	--	--	--	--	
POROUS PAVEMENTS																	
Grasspave **Invisible Structures, Inc.**	suspended solids, phosphorous, nitrogen, heavy metal, hydrocarbons	peak demand parking (shopping centers, parks), occasional/infrequent parking (church), event parking (stadium), guest parking (single family)	95%	--	--	--	--	--	--	--	--	--	--	--	--	--	
Gravelpave **Invisible Structures, Inc.**	suspended solids, phosphorous, nitrogen, heavy metal, hydrocarbons	residential, municipal	95%	--	--	--	--	--	--	--	--	--	--	--	--	--	

SCREENING RESULTS

Water Quality Control Technologies
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2
July 1, 2004
EC Project No 2028.102

Technology/Manufacturer	Targeted Materials Captured	Application	TSS	TP	TN	COD	BOD	Pb	FC	FS	TOC	TPH	OG	Zn	other 1	other 2
Rainstore **Invisible Structures, Inc.**	--	residential, municipal	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Water Quality Control Technologies
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2
July 1, 2004
EC Project No 2028.102

Technology/Manufacturer	Targeted Materials Captured	Application	TSS	TP	TN	COD	BOD	Pb	FC	FS	TOC	TPH	OG	Zn	other 1	other 2
SEDIMENTATION AND/OR FILTRATION CHAMBERS																
Computer Controlled Cartridge Filtration System **AquaLogic**	oil, grease, debris, sediment	commercial	95%	--	--	--	--	Yes	74%	--	--	70%	--	74%	--	--
Aqua-Filter: Stormwater Filtration System **AquaShield (MKM Sales, Inc.)**	soluble and insoluble hydrocarbons, phosphorus, nitrogen, volatile organic compounds, organically bound heavy metals (lead, copper, zinc, chromium)	commercial	92%	95%	--	--	--	--	37%	--	--	95%	100% floatable	95%	floatable debris	--
BioStorm Stormwater Treatment Systems **Bio-Microbics**	trash, sediment, oil, suspended solids	residential, commercial	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water Quality Vault **CrystalStream Technologies**	sediment, grit, vegetative material, trash, debris, oil, hydrocarbons	residential, industrial	60 to 90%	20 to 40%	20 to 40%	--	20 to 40%	10 to 30%	--	--	20 to 40%	70 to 90%	70 to 90%	10 to 30%	--	--
UI-SU-2215 HTC Oil/Water Separator **Highland Tank**	sediment, oil, grease	residential, industrial	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Storm Vault **Jensen Precast**	--	--	>80% @ 70mg/L TSS	30 to 40%	40%	40 to 65%	--	30%	--	--	40%	55%	--	35 to 50%	copper 30%	--
Oil-Water Separators **PS International, Inc.**	suspended solids, oil	residential, industrial	--	--	--	--	--	--	--	--	--	--	--	--	--	--
StormFilter **Stormwater Management, Inc.**	--	commercial, industrial, residential	60-90%	20-50%	15-30%	--	--	30-80%	--	--	--	--	70%	40-65%	copper 50-90%	--
StormGate Separator **Stormwater Management, Inc.**	--	commercial, industrial, residential	60%	--	--	--	--	--	--	--	--	min. 150 gal. Of storage	min. 150 gal. Of storage	--	--	--
Vortechs System **Vortechnics, Inc.**	oil, trash	--	80%	40%	20%	--	--	50%	--	--	--	60 to 80%	60 to 80%	50%	--	--

SCREENING RESULTS

Water Quality Control Technologies
Data Collection Summary
Pollutant Removal Efficiencies

Table B-2
July 1, 2004
EC Project No 2028.102

Technology/Manufacturer	Targeted Materials Captured	Application	TSS	TP	TN	COD	BOD	Pb	FC	FS	TOC	TPH	OG	Zn	other 1	other 2
NON-PROPRIETARY																
Baffle Boxes[2]	--	--	70%	--	--	--	--	--	--	--	--	--	--	--	--	--
Vegetative Filter Strips[3]	--	--	85%	--	--	--	--	--	--	--	--	--	--	--	--	--
Infiltration/Exfiltration Trenches[4]	--	--	90%	65 to 75%	60 to 70%	--	90%	--	--	--	--	--	--	--	heavy metals 75 to 99%	bacteria 98%
Extended Detention Ponds[3]	--	--	75%	--	--	--	--	--	--	--	--	--	--	--	--	--
Wet Detention Ponds[3]	--	--	93%	54%[8]	53%[8]	50%	52%[8]	39%	--	--	--	--	--	60%	Cu 58%	--
Sedimentation / Filtration Systems[3]	--	--	89%	61%[8]	31%[8]	67%[8]	51%[8]	80%[8]	36%[8]	65%[8]	61%[8]	--	--	80%[8]	--	--
Vegetated/Grassy Swales[3]	--	--	68%	43%	23%	33%	33%	15 to 67%[7]	--	--	--	--	49 to 75%[7]	16 to 67%[7]	Cu 2 to 46%[7]	--
Constructed Wetlands[3]	--	--	93%	70%[2]	46%[2]	--	--	83%[2]	--	--	9%[2]	--	--	84%[2]	Cu 79%[2]	ammonia 79%[2]
Bioretention Ponds[5]	--	--	90%	75%[6]	--	--	--	--	--	--	--	--	75%[6]	--	--	--
Retention/Re-Irrigation Systems[3]	--	--	100%	75%[6]	--	--	--	--	--	--	--	--	75%[6]	--	--	--

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001
2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004
3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999
4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999
5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003
6 Lower Colorado River Authority (LCRA), "LCRA NPS Technical Manual," 1998
7 American Society of Civil Engineers (ASCE), "A Guide for BMP Selection in Urban Developed Areas," 2001
8 City of Austin, "Environmental Criteria Manual," revisions through 2000
9 City of Austin, "Evaluation of Nonpoint Source Controls, an EPA/TNRCC Section 319 Grant Report, Volume 1. Final Report," December 1997

Water Quality Control Technologies
Data Collection Summary
Maintenance and Cost Information

Table B-3
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Maintenance Requirements (times/year)	Cost (materials)	Cost (installation)	Typical Treatment Area (acres)	Construction Area
BIO RETENTION					
Filterra Stormwater Bioretention Filtration System **Americast**	1	$6700 per 1/4 acre	$2000 per 1/4 acre	36 sq. ft. filter surface area for 1/4 acres impervious	depends on site conditions, has been used in retrofit projects before
INLET (CONSTRUCTED)					
First Flush Cast in Place Filter Units **ABT, Inc.**	2.0	$500-$4000	--	designed to match	need to be formed
Aqua-Swirl: Stormwater Treatment System **AquaShield (MKM Sales, Inc.)**	1	$8800 to $35750	$880 to $3575 (10% of materials)	1.8 to 51 cfs (0.25 to 7.3 acres)	no construction-each system is retrofitted into existing drainage structure or new construction sites
Baysaver Separation System **BaySaver, Inc.**	1	$4,060 to $19,060 for standard units $6,620 to $33,060 for standard units with estimated cost of manholes **BaySaver, Inc. does not supply the manholes.**		0.25 to 100+ acres 1.1 cfs to 22 cfs standard treatment 8.5 cfs to 100 cfs standard bypass greater than 22 cfs call 1-800-229-7283	
Storm Water Treatment Unit (SWTU) **CDS Technologies**	1 to 3, must have vactor truck approx. $500 to $1200 per cleanout	--	--	300+	can either be cast in place or inserted in a standard inlet.
V2B1/UNISTORM **Environment 21, LLC**	0.1-0.3	$5000-$8000/imp ac	$1000-$2000/imp ac	0.30-6.0 imp ac	cut a 15-20 ft section of existing pipe to install product
Storm Trooper Stormwater Interceptors **Park Environmental Equipment**	4	$4,860 to $47,700	$2140 to $32,300	less than 5 acres	0.00826 for installation contractor must break into stormwater discharge piping, can be installed in grass swale
The Stormceptor System **Rinker (Hydro Conduit)**	1	$4000 to $65000	$1200 to $19500	varies	no construction needed
INLET INSERTS					
First Flush Inlet Inserts **ABT, Inc.**	2.0	$500-$4000	--	designed to match	can be sized for existing inlets
Ultra-Urban Filter **AbTech Industries, Inc.**	2 to 4	$120 to $800	$20 to $50	5,000 to 10,000 sq ft impervious per unit	insert for inlets
Aqua-Guard: Catch Basin Insert **AquaShield**	4 to 6	$1350 to $2750	$13.5 to $27.5	1.2 to 2.8 cfs	no construction-each system is retrofitted into existing drainage structure or new construction sites
The Snout: Oil-Water-Debris Separator **Best Management Products, Inc.**	2	starts at $250	varies	varies	varies
ClearWater BMP **Clearwater Solutions**	--	--	--	--	--
DrainPac Stormwater Filtration **Drain Works**	--	--	--	--	--
Hydro-Kleen Filtration System **Hydrocompliance Management, Inc.**	2 to 3 filter changes per year	--	--	--	--
Downstream Defender **Hydro International**	--	--	--	--	--
FloGard+Plus **KriStar Enterprises, Inc.**	annually: 3 system inspections 2 filter cleanings 1 change and disposal of filter media	--	--	--	--

SCREENING RESULTS

Water Quality Control Technologies
Data Collection Summary
Maintenance and Cost Information

Table B-3
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Maintenance Requirements (times/year)	Cost (materials)	Cost (installation)	Typical Treatment Area (acres)	Construction Area
ecoSep high efficiency oil separation **Royal Environmental System**	2 to 4	sized by flowrate	quoted by flowrate	industrial point and non-point source app.'s	typically the technologies vessel's can be retrofit site specifically, in-line or off-line for a majority of applications
ecoStop spill control technology **Royal Environmental System**	2 to 4	sized by flowrate	quoted by flowrate	industrial with ligh liquid spill potential	typically the technologies vessel's can be retrofit site specifically, in-line or off-line for a majority of applications
ecoStorm hydro-dynamic structural stormwater treatment technology **Royal Environmental System**	2 to 4	sized by flowrate	quoted by flowrate	industrial with light liquid spill potential	typically the technologies vessel's can be retrofit site specifically, in-line or off-line for a majority of applications
Inceptor **Stormdrain Solutions**	1 to 2	$780-$1320	NA	1100 gpm	no
StormScreen **Stormwater Management, Inc.**	as required	$8K - $60K approx. $7000 to $9000 per treatable cfs	$1600 to $12000 (cost + 20%)	0.5 to 30 acres	site dependent
Grate Inlet Skimmer Boxes **Suntree Technologies, Inc.**	--	--	--	--	--
Curb Inlet Baskets **Suntree Technologies, Inc.**	--	--	--	--	--
Ultra-DrainGuard **Ultra Tech**	1 to 2	$55 to $84 each	5 to 10 min labor installation	0.25 in/hr per 10 acres of impervious surface	no, simple to install, see our new Ultra-GrateLifter for easy one person grate removal
Ultra-GrateGuard **Ultra Tech**	--	--	--	--	--
Ultra-CurbGuard **Ultra Tech**	--	--	--	--	--
PIPE INSERTS					
Storm Flo Litter Collection Screen **Roscoe Moss Co.**	1 to 2	varies with diameter and length required, typical 25' of 24" dia SST 304 screens can cost approx. $20 - $25K	varies with site conditions	varies	minor modifications may be necessary to attach the litter collection device.
POROUS PAVEMENTS					
Grasspave **Invisible Structures, Inc.**	requires same equipment as lawn care	--	--	--	not recommended for areas of high volume traffic
Gravelpave **Invisible Structures, Inc.**	--	--	--	--	--
Rainstore **Invisible Structures, Inc.**	--	--	--	--	--
SEDIMENTATION AND/OR FILTRATION CHAMBERS					
Computer Controlled Cartridge Filtration System **AquaLogic**	12 to 15 $350 to 1,800/mth	$3,500 to $20,000	varies	0.5 to 25 acres	possibly
Aqua-Filter: Stormwater Filtration System **AquaShield (MKM Sales, Inc.)**	1	$24000 to $110500	$2400 to $11050 (10% of materials)	1.8 to 17.5 cfs	no construction-each system is retrofitted into existing drainage structure or new construction sites
BioStorm Stormwater Treatment Systems **Bio-Microbics**	--	--	--	--	--
Water Quality Vault **CrystalStream Technologies**	3 to 4	$5000 to $25000	$1,500	0.25 to 3 ac w/o bypass 6 ac with bypass	will retrofit existing pipes
UI-SU-2215 HTC Oil/Water Separator **Highland Tank**	--	--	--	--	--
Storm Vault **Jensen Precast**	0.25	5 acres@65% impervious=$45K	5 acres@95% impervious=$65K	1 to 10 acres 20 acres max	product may be installed in existing system given adequate hydraulic grade

SCREENING RESULTS

Water Quality Control Technologies
Data Collection Summary
Maintenance and Cost Information

Table B-3
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Maintenance Requirements (times/year)	Cost (materials)	Cost (installation)	Typical Treatment Area (acres)	Construction Area
Oil-Water Separators **PS International, Inc.**	--	--	--	--	--
StormFilter **Stormwater Management, Inc.**	1	$3K-$100K approx. $10,000 to $15,000 per treatable cfs	cost * 20%	0 to 10 acres	site dependent
StormGate Separator **Stormwater Management, Inc.**	1	$8K-$38K approx. $7000 to $9000 per treatable cfs	cost * 20%	0.1 to 6 acres	recommended for areas with insufficient drop from inlet to outlet; will need reconstruction
Vortechs System **Vortechnics, Inc.**	0.5 to 1	$12000 to $40000	$4000 to $15000	0.5 to 25 acres	the system is typically installed in the drainage system during construction, retrofit or redevelopment of a site
NON-PROPRIETARY					
Baffle Boxes[2]	1 to 2 ($450 per cleanout, $0.05 per kg ($0.11 per pound) of sediment removed.	--	--	less than 20 acres	may be placed under pavement; Manholes must be withing 15ft of a stabilized road for truck access; velocity in box must be less than 2ft/sec
Vegetative Filter Strips[3]	--	--	--	1 to 10 acres	
Infiltration/Exfiltration Trenches[4]	1 to 2	--	--	up to 10 acres	3 to 8ft deep; 2 to 4ft above groundwater
Extended Detention Ponds[3]	--	--	--	greater than 10 acres	--
Wet Detention Ponds[3]	--	--	--	10 acres to 1 square mile	--
Sedimentation / Filtration Systems[3]	1	--	--	less than 10 acres	--
Vegetated/Grassy Swales[3]	minimal (mowing/lawn care; debris/litter removal; sediment removal; grass reseeding/mulching)	--	--	less than 10 acres with slopes from 2% - 6%	invert should be higher than 2 ft above groundwater level; buildings should be 10ft from site
Constructed Wetlands[3]	monthly until vegetation is established. Inspection and nuisance species removal once a year.	--	--	5 to 20 acres and greater than 20[4]	length to width ratio should be 2:1 to 4:1
Bioretention Ponds[5]	*see LCRA*	--	--	up to 1 acre	--
Retention/Re-Irrigation Systems[3]	*see LCRA*	--	--	>10 acres	--

SCREENING RESULTS

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001
2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004
3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999
4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999
5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003
6 Lower Colorado River Authority (LCRA), "LCRA NPS Technical Manual," 1998
7 American Society of Civil Engineers (ASCE), "A Guide for BMP Selection in Urban Developed Areas," 2001
8 City of Austin, "Environmental Criteria Manual," revisions through 2000
9 City of Austin, "Evaluation of Nonpoint Source Controls, an EPA/TNRCC Section 319 Grant Report, Volume 1, Final Report," December 1997.

Water Quality Control Technologies
Data Collection Summary
Product History and Special Needs

Table B-4
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Agency Approvals	1st installed	Cities	Other Reports, Case Studies, Manuals (* denotes third party information)	Special Needs or Comments
BIO RETENTION					
Filterra Stormwater Bioretention Filtration System **Americast**	Virginia DCR: new and redevelopment projects; MD MDE: redevelopment/infill and retrofit applications; District of Columbia: new and redevelopment projects	Navy Yard in Washington, D.C., 2000	U.S. Navy; Pentagon; Town of Littleton, MA; Ocean City, MD	--	price includes a two year service agreement with Americast; best optimized in highly developed, landscaped areas; treats about 90% of annual volume
INLET (CONSTRUCTED)					
First Flush Cast in Place Filter Units **ABT, Inc.**	--	Sep-03	--	--	--
Aqua-Swirl: Stormwater Treatment System **AquaShield (MKM Sales, Inc.)**	RI, MI, ID, NY, VA, WY, MD, CO, DC, CA, AK, TN, HI, GA, PA, MA, IN, plus	2000 in Grand Rapids, MI	Honolulu, HI; Indianapolis, IN; Rockville, MD; Grand Rapids, MI; San Diego, CA, Anchorage, AK; Chattanooga, TN	M2, "Manual," 2003	significant discounts for participating in testing program
Baysaver Separation System **BaySaver, Inc.**	Texas Department of Transportation, Arizona DOT, Oregon DOT, Nevada DOT, New Mexico DOT	1997, Maryland	Over 600 installations nationally both public and private	M5, "BaySaver Separation System…," 2002	maintenance schedule is included; performed with a vacuum truck, usually takes 2 to 4 hours depending on the size of the system; installation instructions are included
Storm Water Treatment Unit (SWTU) **CDS Technologies**	City of Houston, Harris County	Australia, 1992	over 1800 installations in the United States 14 in City of Houston/Harris County 10 in Dallas/Fort Worth	"Oil and Grease Removal by…," 1998* "Continuous Deflection Separation…," 1999* M9, "Hanson Pipe and Products, Inc."	Vactor truck and licensed maintenance crew
V2B1/UNISTORM **Environment 21, LLC**	NYSDOT, ILDOT, CTDOT, Canadian Ministry of Environment	New York State, 1999	Kwidzyn, Poland; Erie County, NY; Sarnia, Ontario; Alpharetta, Georgia	--	--
Storm Trooper Stormwater Interceptors **Park Environmental Equipment**	Southwest Research Institute, City of Houston, Harris County, Garland, Rockwall, Irving, Corpus Christi, Dallas, Ft. Worth, Austin	Latern Bend Professional Building, Houston, TX 2003 First tested in AmeriFourge, Houston, 1994	Houston, TX	M6, "Engineering Manual," 2002*	--
The Stormceptor System **Rinker (Hydro Conduit)**	City of Austin, TxDOT, LCRA, City of Laredo, Port of Houston, Houston International Airport, Houston/Harris County, City of Dallas, etc.	Canada 1993	Over 100 units installed in Texas	"Testing Summary," 2003 M7a, "Owner's Manual," 2003 M7b, "Product and Technical Information"* M7c, "Study Binder"*	--
INLET INSERTS					
First Flush Inlet Inserts **ABT, Inc.**	--	Jan-01	AbTech	--	--
Ultra-Urban Filter **AbTech Industries, Inc.**	EPA "National Menu of BMPs for Phase II", Smart Sponge Technology approved by NOAA	1998 Santa Monic & El Monte, CA	26 states, 10,000 filters installed, cities of Waco and El Paso	"Detailed Technical Field Test…," 1998* "Field Test Results of AbTech…," 2000* "Technical Review of the AbTech…," 2002* "City of Carson Ultra-Urban…," 2002*	vacuum out modules with conventional maintenance equipment, replace filter box every 1-3 years, grate drop in
Aqua-Guard: Catch Basin Insert **AquaShield**	RI, NJ, VA, DC, HI, CA, NC, FL, DE	1998 Chattanooga, TN	Honolulu, HI; Washington DC; San Diego, CA; Chattanooga, TN; Fairfield, CT; U.S. Navy	M2, "Manual," 2003	50 to 100% off for participating in testing program
The Snout: Oil-Water-Debris Separator **Best Management Products, Inc.**	WS DOT; UT DOT; PA DEP, etc.	1999 Haverford, PA, Thomas Friese, P.E. Yerkes Assoc. Engineers 610-525-6200	West Valley City, UT, Trace Robinson, City Engineer, 801-963-3204	--	requires a partition for bypass flow.
ClearWater BMP **Clearwater Solutions**	--	--	--	--	--

FINAL RESULTS

Water Quality Control Technologies
Data Collection Summary
Product History and Special Needs

Table B-4
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Agency Approvals	1st installed	Cities	Other Reports, Case Studies, Manuals (* denotes third party information)	Special Needs or Comments
DrainPac Stormwater Filtration **Drain Works**	--	--	--	--	--
Hydro-Kleen Filtration System **Hydrocompliance Management, Inc.**	--	--	--	--	only circular or rectangular grates.
Downstream Defender **Hydro International**	--	--	--	"Independent Chemical Analysis," 2001 "London Road/RMA Outfall Works," 2001	--
FloGard+Plus **KriStar Enterprises, Inc.**	--	--	--	M3, "Fossil Filter…"*	--
ecoSep high efficiency oil separation **Royal Environmental System**	NYSDOT, VADOT, TNDOT, CTDOT, MNDOT, USACE, City of Portland, OR; FBI (Quantico, VA waste oil facility); NASA and recognized by USEPA, Chief of Industrial Branch	1995 NYSDOT	NYSDOT, VADOT, TNDOT, CTDOT, MNDOT, USACE, City of Portland, OR; FBI (Quantico, VA waste oil facility); NASA and recognized by USEPA, Chief of Industrial Branch	"Oil Water Separator System Design," 2002	industrial
ecoStop spill control technology **Royal Environmental System**	Bonneville power Administration (DOE), USACE, Portland General Electric, SEATAC, LAX and recognized by USEPA, Chief of Industrial Branch	USF Holland terminal, MN, 1998	Municipal, State Federal, fueling stations, oil terminals	--	industrial
ecoStorm hydro-dynamic structural stormwater treatment technology **Royal Environmental System**	Nashville, TN Metro, NYSDOT	Lakeville, NY	--	"Scale Testing Report," 2002	industrial
Inceptor **Stormdrain Solutions**	PADEP, NDOT, NCDOT, BCSCD	Home Depot, Burlington County, NJ	San Diego, Burlington, NJ; Mount Holly, NJ; Winooski, VT; Fairfield, CT; Wilmington, DE; Greendale, IN; Dublin, OH	"Report of Analysis," 2000* "Report of Analysis," 2001* "Certificate of Analysis," 2001*	--
StormScreen **Stormwater Management, Inc.**	Houston, TX; Nashville, TN; Los Angeles, CA; San Diego, CA	Georgia	jurisdictions with trash and debris TMDLs (CA)	--	--
Grate Inlet Skimmer Boxes **Suntree Technologies, Inc.**	--	--	--	"Lakeland Report 3", 2002 "Cocoa Beach Report 3" and "Cocoa Beach Report 4", 2000	--
Curb Inlet Baskets **Suntree Technologies, Inc.**	--	--	--	"Lakeland Report 3", 2002 "Cocoa Beach Report 3" and "Cocoa Beach Report 4", 2000	--
Ultra-DrainGuard **Ultra Tech**	Washington State DOT Approved Products List, Participating in EPA's Environmental Technology Verification Program (ETV) in Griffin, GA	fall of 1997 sold to distributors and installed across the US	over 3000 units installed in Seattle, Washington area by PlanetCPR, (for test data see www.planetcpr.org .. GrateMate program)	pollutant removal testing in progress at lab Participating in EPA's Environmental Technology Verification Program (ETV) in Griffin, GA , www.stormwater-products.com	--
Ultra-GrateGuard **Ultra Tech**	--	--	--	--	--
Ultra-CurbGuard **Ultra Tech**	--	--	--	--	--
PIPE INSERTS					
Storm Flo Litter Collection Screen **Roscoe Moss Co.**	California Dept. of Transportation-pending	Fall 1999, Los Angeles, CA	Caltrans, County of San Diego	--	requires entry into a confined space
POROUS PAVEMENTS					
Grasspave **Invisible Structures, Inc.**	--	--	--	--	--
Gravelpave **Invisible Structures, Inc.**	--	--	--	--	--
Rainstore **Invisible Structures, Inc.**	--	--	--	--	--

FINAL RESULTS

Water Quality Control Technologies
Data Collection Summary
Product History and Special Needs

Table B-4
July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Agency Approvals	1st installed	Cities	Other Reports, Case Studies, Manuals (* denotes third party information)	Special Needs or Comments
SEDIMENTATION AND/OR FILTRATION CHAMBERS					
Computer Controlled Cartridge Filtration System **AquaLogic**	TCEQ, TxDOT, San Antonio Water Systems	1998 in San Antonio, TX	TxDOT, TCEQ, SAWS	M4, "Engineering Manual…," 2000	response from Dale Stein, TxDOT, completed user questionnaire but didn't provide useful information
Aqua-Filter: Stormwater Filtration System **AquaShield (MKM Sales, Inc.)**	California EPA's Environmental Technology Certification Program; RI; MI; ID; NY; VA; WY; MD; CO; DC; CA; AK; TN; plus	1998 Oklahoma City, OK	Jackson, WY; Rockville, MD; Grand Rapids, MI; San Diego, CA; Anchorage, AK	M2, "Manual," 2003	50 to 100% off for participating in testing program
BioStorm Stormwater Treatment Systems **Bio-Microbics**	--	--	--	--	--
Water Quality Vault **CrystalStream Technologies**	--	Atlanta, GA; Feb. 2000	long list of clients in product information	"Design Criteria-CrystalStream," 2003.	--
UI-SU-2215 HTC Oil/Water Separator **Highland Tank**	--	--	--	--	--
Storm Vault **Jensen Precast**	City of Secramento, CA; City of Portland, OR	Sacramento, CA and Charlottesvill, VA	City of Reno Corporation Yard, Albemarle County Building in Charlottesville, VA; South Lake Tahoe, NV; Incline Village, NV	"Analysis of the Jensen Precast…", 2001. "Testing of the Jensen Precast…", 2002. "Field Testing of the Jensen…", 2001*	--
Oil-Water Separators **PS International, Inc.**	--	--	City of Long Beach, CA; Reliant Equistar, TX; Southwest Airlines, El Paso, TX; Kelly International Airport, San Antonio, TX; George Bush Intercontinental Airport, Houston, TX	--	seems to be used primarily in industrial or high traffic areas, may not be feasible in residential are
StormFilter **Stormwater Management, Inc.**	WA; MD; VA; NJ; NY; Houston, TX; Portland, OR	1992 Washington County, OR	WA; MD; VA; NJ; NY; Houston, TX; Portland, OR	M1, "Product Design Manual", 2002 "Total Suspended Solids Removal…," 2003 "Stormwater Management StormFilter …," 2003	--
StormGate Separator **Stormwater Management, Inc.**	Houston, TX; Nashville, TN; Los Angeles, CA; San Diego, CA	1997 as pretreatment for coarse sand and oil	Houston, TX; Nashville, TN; Los Angeles, CA; San Diego, CA	"Evaluation of the StormGate Separator…," 2003	recommended for areas with insufficient drop from inlet to outlet
Vortechs System **Vortechnics, Inc.**	CT; MA; ME; OH; KS; NY; RI; MI	1993, Portland, Maine	City of Middleton Public Works Dept, CT; Town of Norfold, MA; NY Dept of Transportation	M8a, "Engineered Stormwater Products"* M8b, "Product Review"*	--

FINAL RESULTS

Water Quality Control Technologies
Data Collection Summary
Product History and Special Needs

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July 1, 2004
Project Number 2028.102

Technology/Manufacturer	Agency Approvals	1st installed	Cities	Other Reports, Case Studies, Manuals (* denotes third party information)	Special Needs or Comments
NON-PROPRIETARY					
Baffle Boxes[2]		--	Brevard County, Florida	EPA, "Storm Water Technology Fact Sheet…," 2001	--
Vegetative Filter Strips[3]	EPA, TCEQ, LCRA, City of Austin	--	--	--	--
Infiltration/Exfiltration Trenches[4]	CASQA, EPA	--	--	ASCE, "Guide for Best Management Practices…," 2001	--
Extended Detention Ponds[3]	TCEQ, LCRA, City of Austin	--	--	--	--
Wet Detention Ponds[3]	TCEQ, LCRA, City of Austin	--	--	ASCE, "Guide for Best Management Practices…," 2001	--
Sedimentation / Filtration Systems[3]	TCEQ, LCRA, City of Austin	--	--	--	--
Vegetated/Grassy Swales[3]	TCEQ, LCRA	--	--	--	alternative for curb and gutter
Constructed Wetlands[3]	TCEQ	--	--	ASCE, "Guide for Best Management Practices…," 2001	may not be effective in Austin because of limited rainfall and high rates of evapotranspiration.
Bioretention Ponds[5]	LCRA, CASQA	--	--	--	--
Retention/Re-Irrigation Systems[3]	TCEQ, LCRA, City of Austin	--	--	--	--

1 Georgia Stormwater Management Manual, "Alum Treatment System," 2001
2 England, Gordon, David Dee, Stuart Stein, "Stormwater Retrofitting Techniques for Existing Development," 2004
3 Texas Commission on Environmental Quality, "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," 1999
4 U. S. Environmental Protection Agency, "Storm Water Technology Fact Sheet: Infiltration Trench," 1999
5 California Stormwater Quality Association, "California Stormwater BMP Handbook, New Development and Redevelopment," 2003
6 Lower Colorado River Authority (LCRA), "LCRA NPS Technical Manual," 1998
7 American Society of Civil Engineers (ASCE), "A Guide for BMP Selection in Urban Developed Areas," 2001
8 City of Austin, "Environmental Criteria Manual," revisions through 2000
9 City of Austin, "Evaluation of Nonpoint Source Controls, an EPA/TNRCC Section 310 Grant Rrport, Volume 1, Final Reprot," December 1077
☆ Denotes short list products to be considered in alternative analyses and preliminary engineering studies.