Stormwater Control Manual for the Scrap Recycling Industry

Phase II Stormwater Research

December 2017

Disclaimer

The inclusion of products listed or third party links are to assist the reader or user with stormwater compliance relevant to this paper. However, ISRI has not screened the products listed or the individual links or companies that may appear on the listed links. The products listed, the pointers to information created herein and the external links are provided for the reader's or user's convenience. The inclusion of the links or pointers to particular products is not intended to reflect their importance nor is it intended to be an endorsement by ISRI of any views expressed or of the products. ISRI does not endorse individual products, vendors or services. Any reference herein to any product, vendor, or services by trade name, trademark, or manufacturer or otherwise does not constitute or imply the endorsement, recommendation or approval of ISRI. Furthermore, ISRI makes no claims, promises, or guarantees about the accuracy, completeness, or adequacy of the contents of such links, and expressly disclaims liability for errors and omissions in the contents of the listed websites. No warranty of any kind, implied, expressed, or statutory, including but not limited to the warranties of non-infringement of third party rights, title, merchantability, fitness for a particular purpose or freedom from computer virus, is given with respect to the contents of these websites or its links to other Internet resources.

Table of Contents

Section One Introduction

The Institute of Scrap Recycling Industries (ISRI) sponsored a two phase stormwater study to help scrap metal recyclers implement effective stormwater management programs that comply with federal and state stormwater regulations. Phase I of the ISRI Study, conducted by AECOM in 2010, summarized water quality data collected at scrap recycling facilities in 19 states, the District of Columbia, and Puerto Rico over the period of 1995 through 2009.

Phase II of the ISRI Study was conducted over the period of 2011 through 2016 by a research team that included Stormtech, Inc.; Biohabitats, Inc.; Dr. Robert Pitt from the University of Alabama; and Dr. Shirley Clark from Penn State University. The team coordinated its efforts with ISRI staff and an ISRI Storm Water Task Force. The purpose of the Phase II Study was to define the stormwater-related regulatory issues facing the scrap recycling industry, to identify and characterize Best Management Practices used by the industry, and to prepare a stormwater compliance strategy that reflects developing trends in stormwater regulations and the increased use of stormwater treatment systems. Recommendations are provided to help scrap recyclers evaluate and select effective controls that comply with stormwater permits.

During the period of study, the Phase II scope was expanded to include a two-year stormwater sampling study conducted at six scrap recycling facilities by Drs. Clark and Pitt. The sampling study evaluated the performance of seven stormwater treatment systems that were based on three fundamental treatment technologies: sedimentation, filtration, and chemical treatment (coagulation-flocculation). The results help determine the pollutant removal performance of the treatment systems; describe design, construction, and operation and maintenance features that can affect system performance; and provide a credible database that was used to calibrate an ISRI version of WinSLAMM, a water quality simulation model that can be used to estimate treatment effectiveness.

Section Two Stormwater Characteristics

Scrap metal recycling facilities typically range in size from less than one acre to over 100 acres. Such facilities often have several buildings, large outdoor paved areas, compacted soils, and outdoor operations with exposed scrap material stockpiles, scrap processing (torching, baling shearing, and shredding), heavy equipment, and fueling and maintenance activities. A large amount of metal scrap is exposed to stormwater runoff.

The Phase I ISRI Study examined 17 parameters, including eight metals, with a total of over 34,000 data points. While some improvement in water quality was observed over this 15 year period, the study found that levels of certain metals and total suspended solids often exceeded limits established by government regulators. Concentrations of metals in scrap facility runoff are often higher than levels found in typical urban runoff or in runoff from most other industries.

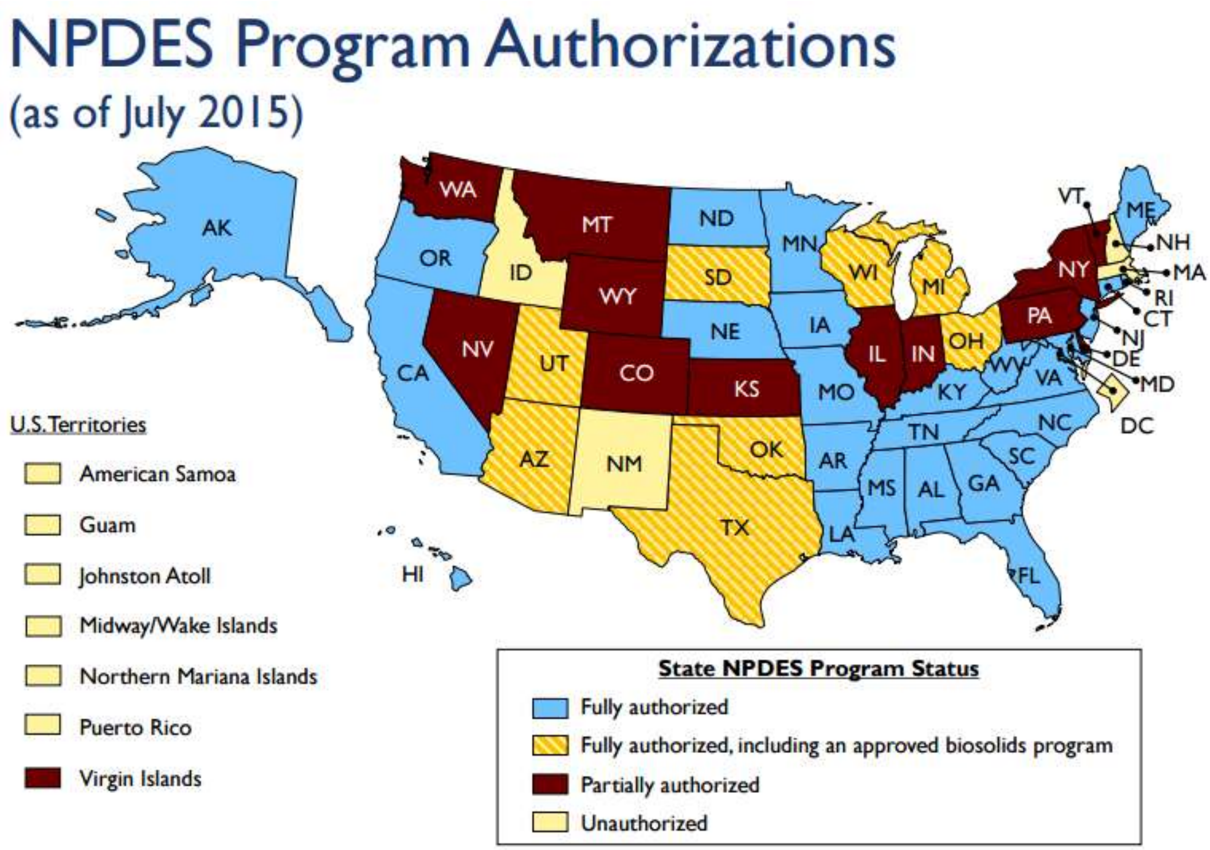
One analysis of particle size distributions in scrap facility runoff found that more than one-half of the sediment mass in runoff was less than 10 µm in size. Limited particle size analyses conducted under the Phase II stormwater sampling study found that particle sizes were slightly larger, with the predominant sizes being 10 to 20 µm. Such small particles are readily transported in runoff and can be difficult to control. Most of the metals are particulate, with the exception of zinc which is about 60% filterable. The term “filterable” refers to the portion of the pollutant concentration than can pass through a 0.45 micron filter. The filterable component may include dissolved ionic, colloidal, and other factions.

Median Water Quality Conditions in Stormwater Runoff from Scrap Recycling Facilities: 1995-2009

Total Suspended Solids	56.0 mg/L
Chemical Oxygen Demand	84.0 mg/L
Oil & Grease	6.0 mg/L
Iron	2.02 mg/L
Copper	0.07 mg/L
Zinc	0.20 mg/L
Aluminum	1.50 mg/L
Cadmium	0.0051 mg/L
Chromium	0.0155 mg/L

Source: ISRI Phase I Stormwater Study, 2010

Industrial stormwater permits were first issued in the early 1990s, under the U.S Environmental Protection Agency (USEPA)-administered National Pollutant Discharge Elimination System (NPDES) permit regulations at 40 CFR §122. These regulations imposed a permit system designed for wastewater discharges upon stormwater discharges associated with industrial activity. In most states, the USEPA has delegated administration of the stormwater permits to state environmental regulatory agencies. In Idaho, New Mexico, New Hampshire, Massachusetts, and most U.S. territories and Indian lands, the permits are administered by USEPA. Since 1995, USEPA has issued Multi-Sector General Permits (MSGPs) to states and territories under its jurisdiction, and generally encouraged delegated states to adopt permits that are consistent with the MSGP.



Federal and State regulators believe that additional reductions in municipal, construction – related, and industrial stormwater pollutants will be required to achieve water quality standards in many lakes and streams. There is a growing prevalence to shift away from "Best Management Practice-based" permit approaches and to instead require industries to quantify the benefits of their stormwater management programs and to demonstrate that receiving waters are adequately protected. Increasingly, stormwater permits are incorporating strict stormwater sampling requirements, numeric limits (often referred to as benchmarks, numeric action levels, or numeric effluent limits), and mandated corrective actions.

USEPA and several states are developing web-based electronic databases for all compliance related documents. Such databases are readily accessible not only to regulators but also to environmental organizations and the general public, which further exposes industries to enforcement actions and third party lawsuits.

These changes are resulting in complicated permits that entail large administrative and compliance costs, extensive record keeping and reporting, the consideration of expensive stormwater treatment controls to supplement Best Management Practices, and increased risk of enforcement. In some cases, state or local regulations require industries to meet total maximum daily load (TMDL) wasteload allocations to help resolve watershed impairments, to incorporate Low Impact Development (LID) practices to reduce the volume and peak flow of stormwater runoff and segregate cleaner stormwater (such as runoff from rooftops and landscaped areas) to meet pre-existing “natural” hydrology, to comply with stormwater construction permits and post-development standards, and to address municipal stormwater (MS4) permit requirements. LID practices and infiltration systems will generally not be appropriate for substantial outdoor operations unless the stormwater first receives substantial treatment or the stormwater is segregated.

During a Stormwater Compliance Workshop held in February 2011, ISRI staff, ISRI members, and the Phase II Study Team discussed the stormwater challenges facing the industry. Stormwater permits have a variety of requirements: stormwater pollution prevention plans, inspections, stormwater sampling and analysis, the application of benchmarks and corrective actions if triggered, record keeping, and submittals to regulatory agencies.

With an overall goal of preparing the scrap recycling industry to implement effective stormwater management programs that comply with stormwater permits, the Workshop participants agreed that scrap recyclers need improved stakeholder involvement and additional information and performance data for both Best Management Practices (BMPs) and stormwater treatment technologies.

The following goals were identified:

1. <u>Interface with Stakeholders</u>
   ISRI and its affiliate chapters should continue to engage Federal and State regulators, environmental groups, and other stakeholders to help advance an improved understanding of the nature of the scrap recycling industry, to help stakeholders better understand the practical limits of stormwater control in this industry, to explore the harmful impacts of excessive and unreasonable regulation, and to encourage collaborations and partnerships that can work together to craft stormwater permit approaches that meet the needs of all stakeholders.

   As the indispensable voice of the scrap recycling industry, ISRI can serve as the source of knowledge, research, and education that helps support BMP performance-based approaches, discourages inappropriate numeric limits and mandated volume-based controls, defines the benefits of both BMPs and stormwater treatment measures, and addresses technical issues such as design storms, filterable metal levels, and allowable permit exceedances. The desired outcome includes raising the stature of ISRI as a reliable source of accurate information, sharing knowledge with engaged stakeholders, and facilitating agreed upon reasonable approaches to stormwater permits.

2. Establish Consistent Best Management Practices

   BMPs address all aspects of a scrap recycling operation. Developing a consistent set of BMPs that are practical and effective will help guide recyclers and set reasonable expectations for regulators and other stakeholders.

3. Evaluate Stormwater Treatment Technologies

   The science and technology of stormwater treatment, pre-treatment, volume control, and facility site design and engineering are rapidly changing. Scrap recyclers need a good understanding of the practicality, costs, effectiveness, and maintenance of such systems. It was concluded that a detailed stormwater sampling study should be conducted to establish a reliable and credible database for treatment systems that are suitable for the crap recycling industry.

4. Provide Compliance Assistance to the Scrap Recycling Industry

   ISRI should provide high quality guidance materials, educational assistance, training, and support services to help recyclers understand permit requirements, select BMPs and when necessary stormwater treatment systems, comply with sampling and monitoring requirements, and reduce the risk of an enforcement action or lawsuit. Support materials should include:

   - Technical reports such as the Phase I and Phase II reports developed under the ISRI Stormwater Study
   - Compilations of stormwater sampling data, research results, demonstration case studies, and new treatment studies
   - Education and training through the ISRI Convention & Exposition, seminars, and webinars
   - Regular updates and communications through ISRI publications and resources



Facility design and engineering can be instrumental in effective pollution prevention, runoff management, and permit compliance. The principles discussed below can be applied to existing, expanding, and new scrap recycling facilities. This guidance pertains to both non-scrap storage areas and areas with active scrap storage and processing operations.

Attention to site design can improve runoff source control and allow better selection and placement of pretreatment and runoff management devices. Potential cost savings include operations, maintenance, and construction costs for runoff management efforts. Site design principles most applicable to scrap recycling facilities include:

- Paving currently unpaved areas
- Buildings, cover, and containment
- Stormwater infrastructure
- Clean water segregation
- Rainwater harvesting
- Landscaping

Benefits and Limitations

(+) Prevent pollutants from being mobilized and/or capture and contain them more easily

(+) Improved planning of flow paths to reduce erosion or direct runoff to BMP

(+) Potential for increase in safety

(+) Potential for construction and long-term cost savings

(+) Lessen operation and maintenance requirements for BMPs

(-) Major site design modifications may not be practical at existing sites

(-) Construction and long-term maintenance costs for items such as paving and coverings/roofs may be substantial

(-) Runoff management BMPs typically still needed for permit compliance

Performance

Site design modifications can improve the performance of BMPs and stormwater treatment systems. For instance, pollutant and debris loads can be reduced through pavement sweeping and covering stockpiles. Drainage areas can be manipulated such that they match the target catchment areas for stormwater controls chosen for the site. Flow paths can be consolidated to a single point for large treatment systems (e.g., ponds) or kept relatively distributed for smaller BMPs (catch basin filters).

Siting

Space Requirements

- Most site design changes occur on the surface, rather than the subsurface.
- Additional space may not be needed for changes such as paving, coverings/roofs, or berms.
- Rainwater harvesting (capturing relatively clean water for reuse) will require an area or location to store the water until it can be used later for a beneficial use such as dust suppression or landscape watering.

Location

- The first priority may be site hotspots, such as areas used for refueling, subject to erosion, or used for material processing.
- Site design principles can be implemented in areas that contain scrap storage and processing operations, as well as non-scrap storage areas.
- Consider the placement of site design features relative to other stormwater treatment and conveyance elements to allow a treatment train approach.
- Site design principles can be incorporated into an overall stormwater management system for new, expanding, or existing facilities.

Design

- **Pretreatment –** Improvements to site design can reduce the amount of pretreatment needed by minimizing the amount of particles that are mobilized (e.g., through wash-off or erosion).

- **Material segregation –** Segregating materials can isolate pollutant sources as well as improve safety and operational efficiency.

- **Paving –** Increasing pavement coverage in targeted areas is an industry trend. Runoff management and the location of flow paths should be coordinated with paving plans.

Site Design Elements and Guidelines

Design Element	Notes
Paving	• Paved areas allow for pollutant reduction through regular sweeping, either manually or mechanically. • Berms (including curbs and speed bumps) and shallow swales can be constructed relatively easily and can assist in defining drainage areas and directing flow. • Roadways, employee parking, and storage areas may be paved. • Tracking pads or rumble strips can help knock sediment off tires and reduce tracking of material offsite. • Concrete pads can also be constructed in targeted locations, with runoff directed to a conveyance system or BMP.
Buildings, cover, containment	• Targeted coverage of stockpiles (e.g., fluff and shredded metal) can reduce pollutant loadings and reduce the demands placed on pretreatment and runoff management devices. • Potential for linkage to a rainwater harvesting system.
Stormwater infrastructure	• To simplify construction and maintenance, surface conveyance is preferred when possible. Examples include trenches and swales. • Conveyance design should be coordinated with siting and selection of pretreatment and runoff management devices.

Design Element	Notes
Clean water segregation	• Many strategies can be used to segregate clean water, including paving, covering, and conveyance design. • Depending on regulations, treatment requirements for clean water may be reduced or eliminated.
Rainwater harvesting	• Runoff from roof and from paving in non-scrap storage areas can be diverted. • Surface and subsurface cisterns are available, requiring space for excavation or a new footprint. • Designated uses for the collected water should be identified, such as washing equipment and surfaces, landscape watering, and dust suppression. • Preliminary water balance calculations can help determine the need for and magnitude of a rainwater harvesting system. Software models such as WinSLAMM can help estimate water budgets.
Landscaping	• Landscaping should generally be focused on the non-scrap storage areas of the facility. • For new facilities, maintaining a healthy landscaped area can help reduce the need for stormwater quantity control by lowering overall site imperviousness. • Harvested rainwater can be used to irrigate landscape areas.

Maintenance Requirements

Maintenance activities for most site design elements are simple and can be incorporated into the overall maintenance regime for the site. More targeted maintenance may be needed for elements such as:

- rainwater harvesting
- landscaping
- subsurface conveyance (e.g., catch basins and sewers)

Maintenance and Inspection

Frequency	Activity
Weekly to monthly	• Inspect and correct for significant sediment and debris accumulation on surface flow paths. • Sweep paved areas manually or mechanically and dispose of material properly. Models such as WinSLAMM can help determine optimal sweeping frequencies. • Ensure that vegetation is healthy and adequately watered.
Every 2 to 6 months	• Inspect rainwater harvesting system for proper operation. Eliminate accumulated material and potential clogging sources. Consult manufacturer or designer recommendations for detailed cistern maintenance procedures. Check state and local regulations. • Inspect and correct for sediment and debris accumulation in subsurface conveyance infrastructure.
Every 1 to 2 years	• Inspect pavement and roofs for integrity and correct as needed.
Personnel and operations	• Most maintenance tasks can be performed by existing facility personnel. • Subsurface maintenance may require specialized training, personnel, and/or equipment. • Specialized training or personnel could be needed for rainwater harvesting systems, depending on complexity.

References

Institute of Scrap Recycling Industries, Inc. (1996). "Storm Water Guidance Manual: Scrap Processing and Recycling Facilities." Washington, DC.

Best Management Practices (BMPs) are controls related to the scrap recycling operation or to maintenance of the facility. BMPs must be site specific, but it is useful to have some general guidelines and consistency within the industry. Good BMPs are an essential element of a facility's stormwater pollution prevention plan, and can improve productivity and efficiency, reduce risks and liabilities, protect worker safety, and reduce the need for additional stormwater treatment systems.

The following are recommended BMPs that may be included in stormwater pollution prevention plans:

1. Inbound scrap quality control
   - Identify, inspect, educate, notify, verify

     List potential incoming materials that pose a threat to the facility, the environment, or public safety (e.g., post-burn municipal scrap metal containing residual ash and oil and residues from turnings). Identify materials that are prohibited, and those that require special handling and are accepted only under certain conditions. Inspect incoming loads and the scale and/or when unloaded. Facility truck drivers may perform initial inspection during pickup. Provide appropriate quality control program information to suppliers, customers, and employees. Provide necessary employee training.

2. Spill prevention and response
   - Identify spill prone activities and areas

     Fluid storage areas, equipment maintenance, fueling operations, scrap vehicle processing and crushing, oily scrap and turnings storage areas, scrap processing areas, and any other areas where fluids are used or stored.

   - Prevent and contain spills and leaks

     Provide secondary containment or double-walled tanks, especially for fluids stored outside, fix leaking equipment, contain all scrap-related fluids (solvents, oil, cutting fluids), take corrective action in areas where leaks or spills commonly occur. Comply with federal Spill Prevention Control and Countermeasure (SPCC) plan requirements, if applicable.

- Spill response and cleanup, spill kits

    Be prepared. Have spill kits (typically granular absorbents, pads, and socks) wherever fluids are used or stored. Clean up spills immediately. Clean up stains. Keep spill kits well stocked.

- Disposal of used absorbents

    Disposal of absorbents usually is subject to state regulation. Often the absorbents can be placed in trash and transported to landfill if absorbents are not saturated (no free-flowing fluids). Some states require that used absorbents be recycled or disposed of as a hazardous waste.

- Reporting of major spills to authorities

    Major spills (definition varies) must be reported to state and/or federal authorities. Spills that reach a waterway must be reported. In an emergency, call 911. Refer to federal and state spill reporting requirements.

- Spill control education and training

    Employees must be trained to prevent, clean up, and report spills (if required). Stormwater permits require annual employee training. Document the date, attendance, and topics covered.

3. Equipment preventive maintenance and washing
    - Supplements scheduled maintenance and emergency repairs.
    - Regular documented inspections of stationary and mobile equipment.
    - Document completed repairs and maintenance conducted.
    - Washing equipment outside and discharging wash water often restricted or prohibited – check local/state and permit requirements.

4. Scrap processing

    Equipment controls and material management: Provide secondary containment for stationary equipment with hydraulic systems or that are fuel-powered. Use excellent housekeeping, debris cleanup, and spill control for all scrap processing activities. Vehicles must be fully processed before crushing or shredding. At a minimum, processing of vehicles includes removal of fluids, batteries, refrigerant, and mercury switches. Some states require that tires also be removed.

    - Shredders – shredded product, shredder residue
    - Balers and shears – stationary, portable, mobile
    - Vehicle processing or decommissioning
    - Vehicle crushing and storage of crushed vehicles
    - Appliance processing
    - Torch cutting

5. Scrap management: placement, storage, covering/containment, control of residual or incidental fluids
   - Batteries (lead acid): Store inside building or in covered container. Label and handle according to applicable regulations (e.g., Exempted Recyclable Material, Universal Waste, or Hazardous Waste; check state and local regulations). When recycled, batteries may be subject to reduced requirements. Store damaged batteries separately and contain/clean up spilled acid. Ship in containers or shrink-wrap pallets.
   - Mercury switches and devices: If handling domestic scrap vehicles (domestic manufacturer, pre-2002), participate in End of Life Vehicle Solutions (ELVS) mercury switch removal program. Identify, remove, and recycle other significant mercury containing devices as Universal Waste (e.g., chest freezers and sump pumps).
   - PCB-containing devices and equipment: Identify, contain, appropriate disposal per federal regulations at 40 CFR Part 761.
   - Industrial turnings and borings: Contain cutting oils/fluids, and any storm runoff from oily turnings and borings. Often stored under cover to reduce storm runoff.
   - Oily scrap (scrap vehicle parts, industrial machinery, clips): Contain oily fluids and storm runoff.
   - Electric motors and "meatballs": Store on hard surface (such as concrete). May be a significant source of heavy metals such as copper.
   - Copper wire and tubing: Store on hard surface under cover.
   - Galvanized steel and other zinc coated materials: Consider covering, if practicable. May paint exposed metal fences and rooftops to reduce exposure.
   - Fire/explosive hazards (sealed tanks, fluids, aluminum powder, magnesium, titanium): Follow proper storage for safety and environmental protection.
   - Electronics: Store inside a building or structure.
   - Appliances: Verify prior proper removal of refrigerant or remove refrigerant per 40 CFR Part 82, Subpart F before baling or shredding.

6. Pavement cleaning
   - Sweeping type: Hand, mechanical, vacuum, regenerative air, high-efficiency
   - Frequency of sweeping: Varies – often daily or weekly
   - Disposal of sweeping debris: Usually can be placed in dumpster and taken to landfill.
   - In some states, washing of pavement is prohibited (non-storm water discharge). However, the federal MSGP allows "pavement wash waters where no detergents or hazardous cleaning products are used, where the wash waters do not come into

contact with oil or grease deposits, where there are no industrial materials or hazardous substances – unless the residues are first cleaned up, and where the facility has implemented appropriate BMPs or treatment systems to minimize the discharge of pollutants."

- Simple catch basin filters to trap sediments and absorb hydrocarbons: Inexpensive polypropylene fabric filters can trap large sediment particles. Filters with basket inserts contain absorbents to improve hydrocarbon removal. Advanced filters have filtration media to capture sediments, metals, and hydrocarbons. Catch basin inserts can clog quickly and need frequent inspections and maintenance.

7. Dust suppression (water spraying)
    - Dust suppression water should not be discharged from the facility

8. Fluid storage and management
    - Hazardous Waste, Used Oil, and Universal Waste requirements
    - Secondary containment or double-wall tanks (especially if stored outside – check state requirements and federal SPCC regulations)
    - Labeling, covers, record keeping
    - Spill Kits

9. Erosion Control
   - Unpaved roadways, debris stockpiles, and scrap storage areas
   - Swales, ditches, and other unpaved drainage ways
   - Controls: surface protection (stone, gravel, riprap), tracking pads, filters (silt fences, wattles, booms, small sediment basins), vegetation
10. Employee Training
   - Annual employee training typically required by stormwater permit
   - Document attendance, date, and topics covered
   - Address pollution sources, observations, sampling results, BMPs, and permit requirements. Particularly important for spill prevention and response.

11. Non-stormwater discharges
   - Stormwater permits require industries to document evaluations for the presence of authorized and prohibited non-stormwater discharges
   - Authorized discharges typically include landscape watering, irrigation drainage, foundation and footing drainage, groundwater seepage, atmospheric condensate (refrigeration, air conditioners), potable water, "clean" pavement wash water, and fire hydrant and response system testing and flushing
   - In some locations, equipment and vehicle washing may be allowed with certain restrictions
   - Authorized discharges must not be contaminated or cause nuisances
   - All other discharges are prohibited, including wastewater, building floor drains, contact or non-contact cooling water, process water, sanitary water, and spills and leaks
   - Prohibited discharges and contaminated authorized discharges must either be eliminated or covered under a separate NPDES permit

12. Natural drainage ways, streams, and wetlands
   - Support healthy vegetative growth, particularly along the shoreline
   - Stabilize storm water discharge locations
   - Provide a buffer zone (usually vegetated): often 10 – 25 feet
   - Prevent filling, disturbance, oil sheens, sediment deposits, scouring and habitat damage
   - Prevent placement of scrap, debris, equipment, or parts within the buffer zones
   - Immediately respond and clean up any problems that threaten these waterways
   - Strict federal and state wetland regulations apply

13. BMP performance evaluation, documentation, and record keeping

- Often part of permit-required monthly or quarterly inspections
- Record observations, corrective actions needed, responsible person, and completion of corrective actions
- Evaluate and improve BMPs as needed to comply with stormwater pollution prevention plan, stormwater sampling limits, and Total Maximum Daily Load (TMDL) requirements, and as directed by a regulatory agency

Stormwater treatment technologies can be effective at removing high sediment, organic material, and metal loadings, and together with the above-listed BMPs, may help achieve stormwater limits or benchmarks and TMDL requirements. Not all facilities need stormwater treatment to meet stormwater permit requirements. Generally, these technologies are designed to treat the water and remove additional pollutants at or near the point of discharge from the facility.

The technologies were identified, evaluated, and compared by reviewing treatment systems known to be used at scrap facilities across the United States; by conducting a detailed professional literature review of features, benefits, limitations, siting constraints, pollutant removal performance, design elements, cost, and operation and maintenance requirements; and by simulating the pollutant removal performance of each technology with the WinSLAMM (Source Loading and Management Model for Windows) water quality model. In addition, the performance of several sedimentation, filtration, and coagulation-flocculation systems were monitored under the ISRI Stormwater Sampling Study. The sampling results were used to develop an industry-calibrated version of the WinSLAMM model.

The following treatment technologies were evaluated:

1. **Pre-Treatment:** Due to heavy sediment loadings at scrap recycling facilities, a pre-treatment device is recommended to remove larger sediment particles and hydrocarbons that could clog treatment systems and reduce performance.

2. **Stormwater Dry Basins and Ponds:** Basins and ponds (and related systems such as constructed wetlands) provide large scale control of both water quantity and quality. Pollutant removal is through sedimentation, plant uptake, microbial processes, and other chemical and biological interactions.

3. **Biofilter:** A biofilter, also known as bioretention, uses vegetation, a filter media, and often detention to treat runoff and remove pollutants. Biofilters may be most appropriate to treat runoff from “cleaner” areas of a facility such as parking areas or rooftops.

4. **Media Filter:** A media filter, or filtration system, is an above- or below-ground device that allows the water to pass through filter media to remove pollutants. Types of media suitable for a scrap recycling facility include sand, activated charcoal, peat, and zeolite.

5. **Enhanced Vaults:** An enhanced vault is an underground sediment tank that incorporates enhancements such as a larger permanent pool, baffles, inclined plates, or oil/water separator to improve performance.

6. **Treatment Train:** A treatment train is a series of at least two chambers or devices used to treat storm runoff. The first part of the treatment system usually provides detention to remove sediment and debris and may be enhanced with tube settlers or similar features. The second chamber can be a media filter often composed of sand and peat, chemical treatment, or biofilter. Each part of the train protects and enables the next part to function as designed. Through a combination of screening, settling, sorption, ion exchange, and filtration, properly designed treatment trains can achieve a high level of pollutant removal.

7. **Proprietary Systems:** Proprietary systems operate on the same fundamental unit processes as the treatment systems described above. Proprietary systems are commercially available treatment devices. Systems that have been used by scrap recyclers include hydrodynamic devices such as Vortech® and StormCeptor®, the ConTech StormFilter®, StormwateRx® systems, WaterTectonics®, the Hydro International Up-Flo Filter®, chemical treatment systems (coagulation – flocculation), and many others.

Note: ISRI does not recommend or endorse any proprietary treatment system. The Phase II Study Team was aware that the above-listed systems have been used at scrap recycling facilities. Be skeptical of performance claims by manufacturers and distributors; request independent study results. Consider retaining a professional engineer or consultant to assist you in selecting, designing, and installing a treatment system.

The performance of treatment systems is generally assessed by evaluating the percent of the pollutant load removed and the pollutant effluent concentrations (after treatment). Treatment systems for facilities that have high pollutant concentrations may achieve a fairly high % reduction in the pollutant load, yet have effluent concentrations that still exceed state or federal limits or benchmarks. Conversely, treatment systems for facilities that already have low pollutant concentrations may achieve a low % reduction in the pollutant load, but likely meet the limits or benchmarks.

The following stormwater treatment matrices provide a comparison of these technologies. The treatment technologies are evaluated for:

- treatment performance
    - pollutant removal
    - effluent concentrations (to determine if benchmarks or limits can be met)
    - peak flow control
    - water volume reduction

- physical feasibility
    - maximum drainage area
    - space requirement
    - surface (above ground) or subsurface (below ground)
    - excavation depth for installation

- owner considerations
    - construction cost (January 2017 cost)
    - maintenance considerations
    - disposal of captured sediments
    - ease of maintenance
    - regulatory acceptance
    - limitations

To provide comparable costs, the matrix shows the construction cost per impervious (paved or rooftop) acre treated. Another way to consider cost is to examine the cost per volume of water treated. As an example, the construction cost of a pond is estimated at $46,000 per impervious area treated. Although runoff amounts vary widely across the United States, let's assume a typical runoff amount of 24" of runoff per year from an impervious surface. Under that scenario, the pond cost could also be expressed as $23,000/acre-foot of runoff/year; as $0.53/cubic-foot of runoff/year; or as about 7 cents/gallon of runoff/year. That construction cost is distributed across the life of the treatment system, which for a pond may be expected to be 20 years of more. Of course, operation and maintenance costs must also be included.

Attribute		Pond / Wetland			Media Filtration		
Description		Basin which fills during storm events. May or may not have a permanent pool. Primarily provides sedimentation; however, other biological and chemical processes also occur. Includes dry detention basins, wet ponds, and wetlands	Pond 1	Pond 2	Pretreatment basin followed by a filter containing specialized media to address pollutants of concern. Can be implemented underground to minimize footprint.	Mixed Media	Up-Flow Sand Filter
ISRI Stormwater Sampling Study Source =>		-	Table 16A		-	Table 17A	
Stormwater Treatment							
TSS / **SSC**	Median Removal (%)	50 - 80	**72**	**52**	85	**13**	**19**
	Median Influent Conc. (mg/L)		**208**	**60**		**31**	**29**
	Median Effluent Conc. (mg/L)	13 - 31	**37**	**31**	16	**19**	**19**
O&G	Median Removal (%)	70 - 80			85	-	-
	Median Influent Conc. (mg/L)					-	-
	Median Effluent Conc. (mg/L)	-			-	-	-
Lead	Median Removal (%)	-	71	56	-	64	47
	Median Influent Conc. (µg/L)		370	213		21	93
	Median Effluent Conc. (µg/L)	3.3 - 16	65	130	3.8	7	27
Copper	Median Removal (%)	30 - 60	65	49	40	61	38
	Median Influent Conc. (µg/L)		500	125		28	80
	Median Effluent Conc. (µg/L)	4.2 - 12	120	94	10	14	36
Zinc	Median Removal (%)	30 - 65	62	31	90	-	40
	Median Influent Conc. (µg/L)		830	410		-	890
	Median Effluent Conc. (µg/L)	29 - 60	220	380	38	-	380
Peak Flow Control		medium-high			low-medium		
Volume Reduction		low - (medium for wetlands)			low		
Physical Feasibility Considerations							
Maximum Drainage Area (acres) (may be limited by local or state regulations)		≤ 100			1 - 10		
Space Requirement		high			low		

Attribute	Pond / Wetland			Media Filtration		
Description	Basin which fills during storm events. May or may not have a permanent pool. Primarily provides sedimentation; however, other biological and chemical processes also occur. Includes dry detention basins, wet ponds, and wetlands	Pond 1	Pond 2	Pretreatment basin followed by a filter containing specialized media to address pollutants of concern. Can be implemented underground to minimize footprint.	Mixed Media	Up-Flow Sand Filter
ISRI Stormwater Sampling Study Source =>	-	Table 16A		-	Table 17A	
Surface or Subsurface	Generally surface; underground detention is a variant			Either		
Maximum Drainage Area (acres) (may be limited by local or state regulations)	2 to 8 - depending on system			4 to 8		
Property Owner Considerations						
Construction Costs (Jan. 2017): $ / impervious acre treated	`$46,000			$105,000 - 365,000		
Specific Maintenance Considerations	Major task is removing sediment from forebay. Management of invasive plants may be required			Typically requires scraping clogged layer off media surface and removing sediment from pretreatment area. Confined space entry needed if underground.		
Special Disposal of Sediments Removed During Maintenance	yes			yes		
Maintenance Difficulty	low - maybe moderate if high influent sediment load requires frequent forebay servicing			low - maybe be high if underground and confined space entry required		
Regulatory Acceptance	high			high		
Limitations	Removal of small particles may necessitate use of chemical additives. May pose groundwater impacts risk if unlined.			Frequent maintenance required to maintain permeability. Specialized equipment may be needed to maintain the system. May pose groundwater impacts risk if unlined. Partial media replacement may be needed to restore permeability.		

Attribute	Pond / Wetland			Media Filtration		
Description	Basin which fills during storm events. May or may not have a permanent pool. Primarily provides sedimentation; however, other biological and chemical processes also occur. Includes dry detention basins, wet ponds, and wetlands	Pond 1	Pond 2	Pretreatment basin followed by a filter containing specialized media to address pollutants of concern. Can be implemented underground to minimize footprint.	Mixed Media	Up-Flow Sand Filter
ISRI Stormwater Sampling Study Source =>	-	Table 16A		-	Table 17A	

Notes:
TSS = Total Suspended Solids; SSC = Suspended Solids Concentration O&G = Oil & Grease; **Bold** means SSC in lieu of TSS; <u>Underline</u> means that statistical significance across samples was not achieved. These views are provided for informational purposes.

Attribute		Treatment Trains (MCTT)				Enhanced / Modified Vault		
Description		System of three chambers, each providing various removal mechanisms. Performs well for target pollutants at scrap recycling facilities. Can be installed underground.	Sed.-Coag.-Sed.	Sed.-Mixed-Media-Filter	Sed.-Infiltration-Dry-Pond	Combines the conveyance capability of a traditional stormwater vault with water quality features such as a permanent pool, baffles, inclined plates, and oil / water separators.	Sed. 1	Sed.-Baff.
ISRI Stormwater Sampling Study Source =>			Table 19A			-	Table 15A	
Stormwater Treatment								
TSS / **SSC**	Median Removal (%)	85	**96**	**63**	**86**	-	**<u>45</u>**	**27**
	Median Influent Conc. (mg/L)		**782**	**40**	**272**		**<u>40</u>**	**272**
	Median Effluent Conc. (mg/L)	5.5	**11**	**19**	**37**	38	**<u>31</u>**	**208**
O&G	Median Removal (%)	96	<u>-</u>			-		
	Median Influent Conc. (mg/L)		<u>-</u>					
	Median Effluent Conc. (mg/L)	< 0.89	<u>-</u>			-		
Lead	Median Removal (%)	93 - 96	99	94	86	-	<u>2</u>	<u>21</u>

Attribute		Treatment Trains (MCTT)				Enhanced / Modified Vault		
Description		System of three chambers, each providing various removal mechanisms. Performs well for target pollutants at scrap recycling facilities. Can be installed underground.	Sed.-Coag.-Sed.	Sed.-Mixed-Media-Filter	Sed.-Infiltration-Dry-Pond	Combines the conveyance capability of a traditional stormwater vault with water quality features such as a permanent pool, baffles, inclined plates, and oil / water separators.	Sed. 1	Sed.-Baff.
ISRI Stormwater Sampling Study Source =>			Table 19A			-	Table 15A	
	Median Influent Conc. (μg/L)		1750	47	450		47	450
	Median Effluent Conc. (μg/L)	< 2	2.5	6.8	65	11	21	370
Copper	Median Removal (%)	65	99	91	78	-	51	24
Copper	Median Influent Conc. (μg/L)		940	71	550		71	550
Copper	Median Effluent Conc. (μg/L)	15	<15	14	120	14	28	500
Zinc	Median Removal (%)	91	99	68	79	-	83	16
Zinc	Median Influent Conc. (μg/L)		9800	630	1000		630	1000
Zinc	Median Effluent Conc. (μg/L)	18	27	170	210	80	100	830
Peak Flow Control		low				low-medium		
Volume Reduction		low				low		
Physical Feasibility Considerations								
Maximum Drainage Area (acres) (may be limited by local or state regulations)		≤ 2.5 (verified performance in this range)				≤ 5		
Space Requirement		low				low		
Surface or Subsurface		Subsurface				Subsurface		
Excavation depth		4 to 8				4 to 8		
Property Owner Considerations								
Construction Costs (Jan. 2017): $ / impervious acre treated		$460,000				$12,000 - 17,000 (additional cost possible for WQ modifications/enhancements)		
Specific Maintenance Considerations		Confined space entry may be required. Sediments and debris must be removed, hydrocarbon pillow replaced, and filter replaced or flushed.				Confined space entry is likely. Sediments, debris, and captured oil and grease must be removed.		

Attribute	Treatment Trains (MCTT)				Enhanced / Modified Vault		
Description	System of three chambers, each providing various removal mechanisms. Performs well for target pollutants at scrap recycling facilities. Can be installed underground.	Sed.-Coag.-Sed.	Sed.-Mixed-Media-Filter	Sed.-Infiltration-Dry-Pond	Combines the conveyance capability of a traditional stormwater vault with water quality features such as a permanent pool, baffles, inclined plates, and oil / water separators.	Sed. 1	Sed.-Baff.
ISRI Stormwater Sampling Study Source =>		Table 19A			-	Table 15A	
Special Disposal of Sediments Removed During Maintenance	yes				yes		
Maintenance Difficulty	high - confined space entry likely				high - confined space entry likely		
Regulatory Acceptance	low - small number of systems currently in use				moderate		
Limitations	Costs may be high due to novelty of technology (contractors not familiar with product, no prefabricated options). Maintenance of each chamber required. Partial media replacement may be needed to restore permeability.				Potential sediment resuspension due to concrete bottom. Additional water quality structures needed in vault to improve pollutant removal performance.		

Notes:
Sed. = Sedimentation; Coag. = Coagulation; Baff. Baffled; TSS = Total Suspended Solids; SSC = Suspended Solids Concentration O&G = Oil & Grease
Bold means SSC in lieu of TSS Underline means that statistical significance across samples was not achieved. These views are provided for informational purposes.

Attribute	Biofiltration	Proprietary Devices			Coagulation
Description	Runoff passes through a vegetated media filter. Can be used for hydrologic improvements. Most appropriate for non-scrap processing areas on facility.	General term for patented stormwater treatment practices. Systems often utilize filters, specialized flow patterns, baffles, and oil / water separators. Can be installed underground.	HDS 1	HDS 2	Coag.-Sed.
ISRI Stormwater Sampling Study Source =>	-	-	Table 14A		Table 18A
Stormwater Treatment					

Attribute		Biofiltration	Proprietary Devices			Coagulation
Description		Runoff passes through a vegetated media filter. Can be used for hydrologic improvements. Most appropriate for non-scrap processing areas on facility.	General term for patented stormwater treatment practices. Systems often utilize filters, specialized flow patterns, baffles, and oil / water separators. Can be installed underground.	HDS 1	HDS 2	Coag.-Sed.
ISRI Stormwater Sampling Study Source =>		-	-	Table 14A		Table 18A
TSS / **SSC**	Median Removal (%)	60	Performance Variable Based on System Utilized - Consult Manufacturer	**40**	-	100
	Median Influent Conc. (mg/L)			**234**	-	1012
	Median Effluent Conc. (mg/L)	24		**54**	-	11
O&G	Median Removal (%)	90				
	Median Influent Conc. (mg/L)					
	Median Effluent Conc. (mg/L)	-				
Lead	Median Removal (%)	-		74	-	100
	Median Influent Conc. (µg/L)			130	-	1700
	Median Effluent Conc. (µg/L)	6.7		30	-	3
Copper	Median Removal (%)	80		66	6	99
	Median Influent Conc. (µg/L)			220	52	725
	Median Effluent Conc. (µg/L)	11		60	48	2
Zinc	Median Removal (%)	80		76	-	100
	Median Influent Conc. (µg/L)			650	-	11450
	Median Effluent Conc. (µg/L)	40		190	-	30
Peak Flow Control		low-medium	low - some products may offer flow control			
Volume Reduction		low (medium for unlined systems)	low - some products may offer runoff reduction			

Attribute	Biofiltration	Proprietary Devices			Coagulation
Description	Runoff passes through a vegetated media filter. Can be used for hydrologic improvements. Most appropriate for non-scrap processing areas on facility.	General term for patented stormwater treatment practices. Systems often utilize filters, specialized flow patterns, baffles, and oil / water separators. Can be installed underground.	HDS 1	HDS 2	Coag.-Sed.
ISRI Stormwater Sampling Study Source =>	-	-	Table 14A		Table 18A
Physical Feasibility Considerations					
Maximum Drainage Area (acres) (may be limited by local or state regulations)	≤ 0.5	≤ 5 (consult manufacturer)			
Space Requirement	high	low			
Surface or Subsurface	Surface	Generally subsurface; some products available for surface			
Excavation depth	3 to 6	4 to 8 - varies based on product			
Property Owner Considerations					
Construction Costs (Jan. 2017): $ / impervious acre treated	$80,000 - 175,000	variable based on product			
Specific Maintenance Considerations	Typical maintenance includes removal of sediment from forebay, pruning vegetation, and mulch improvement or replacement.	Confined space entry usually necessary, typical maintenance may include vacuuming out oils and grease, removing accumulated sediments and debris, and/or replacement of any filters present.			
Special Disposal of Sediments Removed During Maintenance	no - if sited where only treating non-scrap processing portions of facility	yes			
Maintenance Difficulty	medium - may be low if media clogs and needs complete replacement	high - confined space entry likely			
Regulatory Acceptance	high	moderate			
Limitations	Best suited to treat relatively clean areas that are not used to store or process scrap. Partial media replacement may be needed to restore permeability. Vegetation selection is critical, depending on the pollutants.	Specialized equipment / personnel may be required for maintenance.			

Attribute	Biofiltration	Proprietary Devices			Coagulation
Description	Runoff passes through a vegetated media filter. Can be used for hydrologic improvements. Most appropriate for non-scrap processing areas on facility.	General term for patented stormwater treatment practices. Systems often utilize filters, specialized flow patterns, baffles, and oil / water separators. Can be installed underground.	HDS 1	HDS 2	Coag.-Sed.
ISRI Stormwater Sampling Study Source =>	-	-	Table 14A		Table 18A

Notes:
HDS = Hydrodynamic System; Coag. = Coagulation; Sed. = Sedimentation; TSS = Total Suspended Solids; SSC = Suspended Solids Concentration O&G = Oil & Grease
Bold means SSC in lieu of TSS; Underline means that statistical significance across samples was not achieved. These views are provided for informational purposes.

Pretreatment Profile

Description

Stormwater runoff at industrial sites may contain large amounts of sediment and debris. To prevent clogging of stormwater treatment practices and improve their overall performance, it is advantageous to use pretreatment methods to capture sediment and debris. Catch basin sumps, vegetated or rock swales, and hydrodynamic separators are commonly used for pretreatment. Vegetated swales may have limited use in areas with high sediment washoff.

A catch basin sump is a storage pool at the bottom of a catch basin inlet that promotes sedimentation and captures sediment and debris. A vegetated swale is an open channel that filters sediment and debris and allows stormwater to spread out, slow, and drop sediment as it flows through the channel. Hydrodynamic separators are proprietary systems that force various flow patterns in an effort to enhance coarse sediment and debris removal. Hydrodynamic separators may be used at sites that do not have adequate above ground area for other pretreatment options, or where concentrated sediment and debris collection is needed.

Benefits and Limitations

(+) Pretreatment removes coarse sediment, trash and debris from the flow

(+) Reduces sediment accumulation in downstream conveyances and treatment practices

(+) Centralized cleanout access

(-) Maintenance needed for sediment and debris removal

(-) Not a stand-alone treatment practice, only coarse sediment and debris removal

Performance

Pretreatment practices provide water quality treatment primarily by sedimentation. Performance varies based on the type of system, the drainage area characteristics, and the operational flow rate through the device. Scouring may occur at sufficiently high flow rates, releasing captured sediment and reducing the apparent performance. The lower the flow rate relative to the device surface area, the greater the sediment removal.

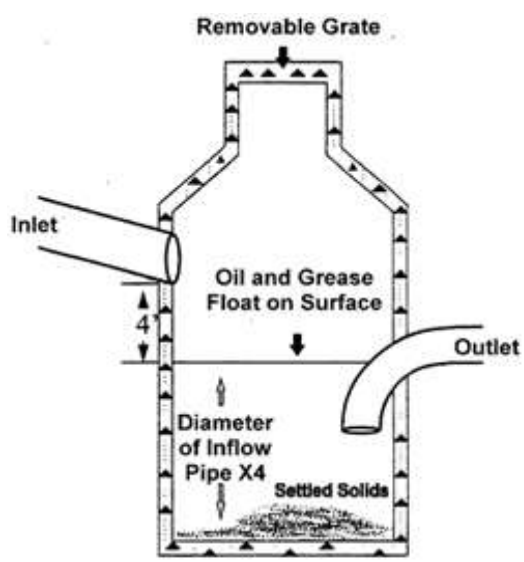
Siting

Space Requirements

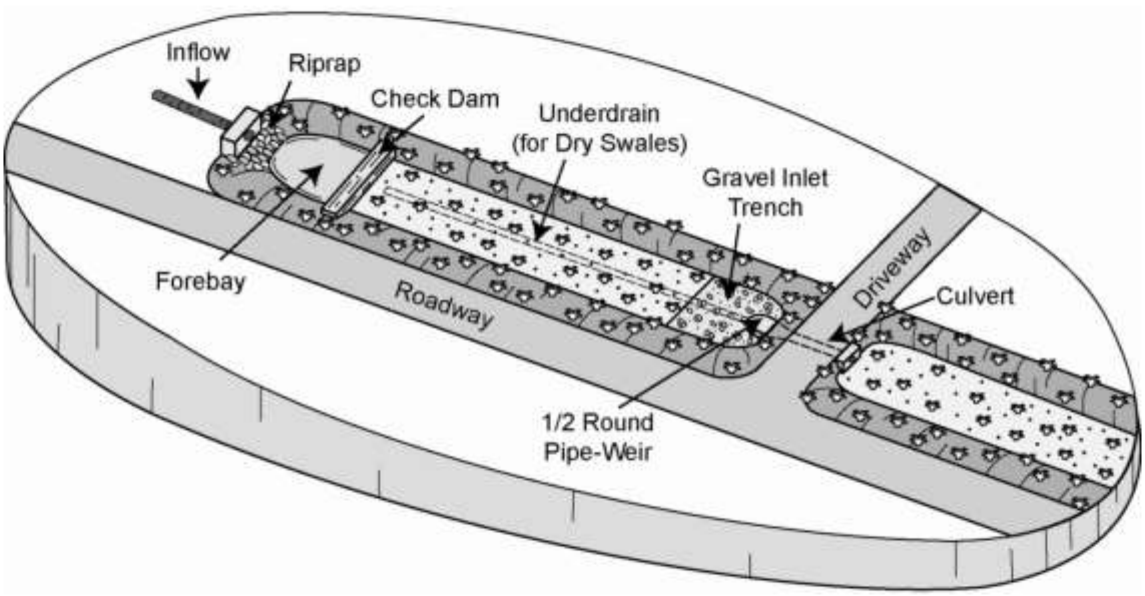
- Catch basin sumps are typically sized to store some predetermined volume of water below the outlet invert. Hydrodynamic separators are sized per individual manufacturer, often based on some target flow rate or volume. Vegetated swales are sized to convey a certain design storm with a residence time long enough to allow for removal of coarse sediments and debris. Therefore, the sizing and space requirement of a pretreatment system is dependent upon the type of system and drainage area characteristics.

Location

- Placed at the upstream end of a stormwater treatment practice, where it is necessary to remove debris and coarse sediments before the flow enters the system.
- Placed downstream of areas suspected or observed to have high sediment and debris loads.



Catch Basin with Deep Sump (Tanski - NYSG)



Typical Vegetated Swale Schematic. Source: Center for Watershed Protection.

Design

Considerations for Scrap Facilities

Stormwater at scrap facilities may be high in suspended solids, metals, and hydrocarbons. Pretreatment practices provide sedimentation to remove coarse suspended solids and any metals and hydrocarbons attached to those particles. Conversely, these systems are not a reliable option for removal of fine sediments and filterable metals.

Design Elements and Guidelines

Design elements and guidelines for each of the three pretreatment practices are presented separately.

Design Elements and Guidelines for Pretreatment Devices

Device	Notes
Catch Basin Sumps	• Sump depth typically four times the diameter of the outlet pipe • May be sized based on anticipated influent sediment load • Access to system must be provided
Hydrodynamic Separator	• Manufacturer suggestions should be utilized • Typically based on some anticipated design flow or volume
Vegetated Swales	• Commonly sized to convey the 10 years storm

Device	Notes
	• Swale slope should not exceed 2 %. Flatter slopes have improved performance • Swale side-slopes (banks) should not be steeper than 3H:1V • Underdrain and liner may be necessary to prevent groundwater impacts

Catch Basin Sumps

Catch basin sumps are typically constructed of reinforced concrete. The catch basin sump is sized to hold some target volume below the invert of the outlet pipe. Depth of the sump is typically at least 4 times the diameter of the outlet pipe (Lager et al, 1997). Alternatively, the sump could be designed to hold the annual coarse sediment load in the runoff to the sump for the desired time interval between maintenance activities, plus a factor of safety (Pitt, 1997).

The inlet and outlet pipe diameters are sized to convey a storm event consistent with that specified in local regulations. Maintenance access to remove coarse sediments and debris should be considered in the sump design. A vacuum truck is typically used to remove sediments from the catch basin sump. The grate over the catch basin inlet should be designed to prevent large debris from entering the catch basin and should be clog resistant.

Hydrodynamic Separators

Hydrodynamic separators are typically proprietary systems that are designed by a manufacturer. The design is based on target removal efficiencies given expected stormwater flow rates or volumes. Site constraints are also important in design, including the structural stability of in situ soils, the water table elevation at the site, and adaptability of existing catch basins to the system.

Vegetated or Rock Swales

State or local guidelines may specify a design storm and swale composition and dimensions. Established urban areas may even prohibit surface water drainage and require the installation of storm sewers. Larger swale channel width, depth, bank slopes, and main channel slope are often designed to carry the 10-year storm with 6 inches of freeboard. The slope of conveyance swales should generally not exceed 2 % to avoid high velocities. Velocities should be no greater than 3 to 5 feet per second when carrying the 2-year storm. Bank slopes should be no greater than 3H:1V to provide stability. Bottom width should be no greater than 8 feet and no less than 2 feet to avoid channelization and gullies from forming. The swale should be designed to hold the water quality volume for a minimum of 30 minutes residence time to achieve maximum treatment (NYSDEC, 2008).

It may be desirable to have a forebay for enhanced sedimentation or for energy dissipation near the upstream end of the swale, particularly if the inflows are arriving via pipe flow. The forebay will also provide easy access for sediment removal. The forebay can be separated from the rest of the swale by a weir to provide a desired pool depth. Level spreaders also have been used to distribute flow across the swale bottom.

Conveyance

Stormwater flow should be diverted to the pretreatment device as overland flow if possible. Erosion must be controlled near the inlet device, where high energy flow can scour the area. Because catch basin sumps and hydrodynamic devices are designed to dissipate energy, flows can typically enter them in their existing conditions (without dissipation). Vegetated swales may need a forebay or pool area at their upstream end if the inflows are erosive. It should be noted that hydrodynamic devices are often capable of receiving pipe flow.

Outflows from the pretreatment device are typically conveyed via pipes to the next segment of the stormwater treatment system. The invert of the outlet pipe should be placed such that proper function is allowed in the pretreatment device. The outlet pipe should be designed to convey the design storm without causing flooding upstream of the pretreatment device.

Sizing

The size of the pretreatment device is dependent upon the characteristics of the portion of the facility that drains to the device, and in the case of hydrodynamic separators, additionally contingent on manufacturer suggestions. Catch basin sumps typically can be installed in place of normal catch basins, resulting in no substantial increase in required treatment area for a facility. Likewise, hydrodynamic separators can be placed underground, resulting in little additional area required for installation. Swales used for pretreatment do require some additional space above that required by any water quality systems installed on the facility. Swale sizing will vary based on the design flow of the treatment system.

Maintenance and Inspection

Frequency	Activity
	Catch Basin Sumps (Pitt, 1985)
Semi Annual	• Inspect/remove accumulated sediments • Inspect/remove accumulated trash/debris • Inspect/repair catch basin inlet for erosion and clogging
When Sump Sediment Volume is 60% or greater	• Remove accumulated sediments
	Hydrodynamic Separators (UNH, 2011, USEPA 1999)
1st year	• Establish sediment and debris inspection and removal frequency based on performance
Periodic	• Sediment and debris removal frequency determined by 1st year observations
	Vegetated and Rock-Lined Swales (CASQA, 2003)
Semi Annual	• Inspect/remove accumulated debris • Inspect for erosion or sediment accumulation • Replant bare vegetation areas • Maintain rock lining
As Needed	• Mosquito control.
As Needed	• Mowing • Weed control • Compost clippings

References

California Stormwater Quality Association (CASQA), Stormwater Best Management Practice Handbook Industrial, 2003.

Lager, J., Smith, W., Finn, R., and Finnemore, E. Urban Stormwater Management and Technology: Update and Users' Guide, US EPA. EPA-600/8-77-014, 1997.

Minnesota Pollution Control Agency (MPCA), Industrial Stormwater Best Management Practices Guidebook.

New York State Department of Environmental Conservation (NYSDEC), New York State Stormwater Management Design Manual, April 2008.

Pitt, R., Bellevue Urban Runoff Project, Final Report, 1985.

Pitt, R., Lilbum, M., Nix, S., Durrans, S., and Burian, S., Guidance Manual for Integrated Wet Weather Flow Collection and Treatment Systems for Newly Urbanized Areas, US EPA. Office of Research and Development, Cincinnati, OH, 1997.

StormwaterCenter.net, Pollution Prevention Fact Sheets: Catch Basins, http://www.stormwatercenter.net/Pollution_Prevention_Factsheets/CatchBasins.htm, Retrieved Online February 16, 2011.

Tanski, J. "Stormwater Runoff Best Management Practices For Marinas: A Guide for Operators." New York Sea Grant Program, Retrieved online 2 Mar. 2011.

United States Environmental Protection Agency (USEPA), Office of Water, Stormwater Technology Fact Sheet, Hydrodynamic Separators, September, 1999.

University of New Hampshire (UNH), Hydrodynamic Separators Fact Sheet, Online Access, March 2, 2011, http://www.unh.edu/erg/cstev/fact_sheets/hs_fact_sheet_08.pdf

Stormwater Basin, Pond, and Constructed Wetland Profile

Description

Dry detention basins, wet ponds, and constructed wetlands are stormwater management facilities that provide large-scale quantity and quality control. Both wet ponds and wetlands have permanent pools, while dry detention basins drain entirely over a short period of time (typically hours or a couple days). These detention systems can be incorporated into an overall stormwater management system for new or expanded facilities.

Basins, ponds, and wetlands provide water quantity management primarily by controlling the peak discharge rate to downstream surface waters. Water quality treatment is provided through sedimentation, plant uptake, microbial processes, and other chemical and biological processes.

Benefits and Limitations

(+) Provide stormwater flow control for large drainage areas

(+) Good removal of particulate and some filterable pollutants

(+) Suitable for use as an end-of-pipe BMP

(-) Space requirements

(-) Periodic sediment and debris removal needed, vegetation maintenance required if present

(-) May pose risk of groundwater impacts if not lined and if close enough to groundwater table

(-) Filtering or chemical precipitation may be necessary for effective removal of small particles. The use of chemical precipitation or flocculation may trigger additional disposal restrictions, depending on the chemical used.

Performance

Ponds and wetlands provide water quality treatment via sedimentation, plant root uptake, and microbial processes. Particles ranging in size from grit to approximately 50 µm can be effectively removed through sedimentation alone. For particles smaller than approximately 50 µm, filtering or chemical precipitation (coagulation-flocculation) may be necessary for effective removal. However, sedimentation devices that are oversized compared to manufacturer's specifications may be able to remove particles as small as 20 µm. The effluent concentrations shown below are affected by the influent concentrations, and therefore may vary substantially.

Unlike many BMPs utilized for water quality improvement, basins, ponds, and wetlands have the ability to reduce peak flows to surface waters and treat large drainage areas. Minimal volume reductions may be realized through evapotranspiration.

Dry Detention Basin Water Quality Performance

Performance		TSS	Pb	Cu	Zn
Annual mass removal (%)	Median	50	-	30	30
	Low	20	-	20	0
	High	70	-	40	40
Effluent concentration	Median	31 mg/L	16 µg/L	12 µg/L	60 µg/L
	Low	16 mg/L	4.7 µg/L	5.4 µg/L	21 µg/L
	High	46 mg/L	27 µg/L	19 µg/L	100 µg/L

Source: Center for Watershed Protection; WERF

Wet Pond Water Quality Performance

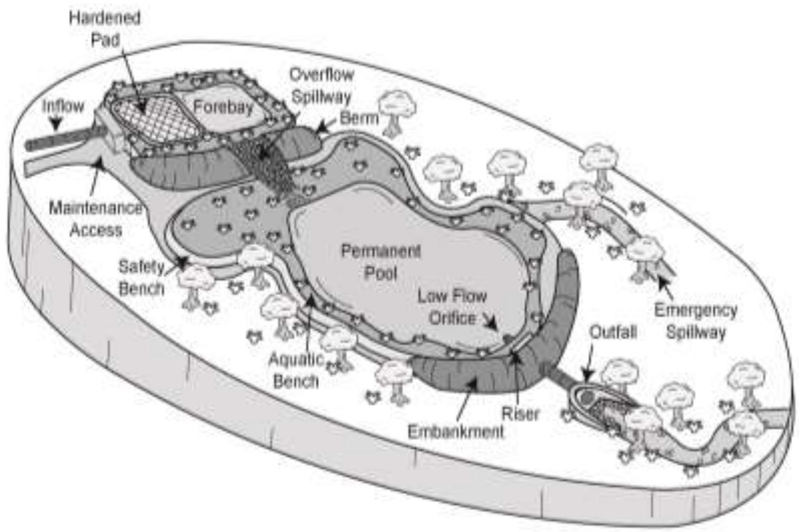
Performance		TSS	Pb	Cu	Zn
Annual mass removal (%)	Median	80	-	60	65
	Low	60	-	45	40
	High	90	-	75	70
Effluent concentration	Median	13 mg/L	5.3 µg/L	6.4 µg/L	29 µg/L
	Low	7.3 mg/L	1.6 µg/L	4.7 µg/L	21 µg/L
	High	19 mg/L	9.0 µg/L	8.0 µg/L	38 µg/L

Source: Center for Watershed Protection; WERF

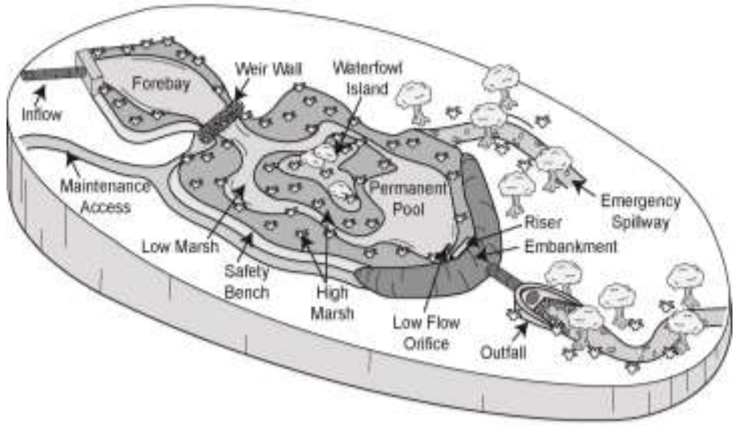
Wetland Water Quality Performance

Performance		TSS	Pb	Cu	Zn
Annual mass removal (%)	Median	70	-	50	40
	Low	45	-	20	30
	High	85	-	65	70
Effluent concentration	Median	18 mg/L	3.3 µg/L	4.2 µg/L	31 µg/L
	Low	9.3 mg/L	2.3 µg/L	0.6 µg/L	13 µg/L
	High	26 mg/L	4.2 µg/L	7.8 µg/L	67 µg/L

Source: Center for Watershed Protection; WERF



Typical Stormwater Pond Schematic. Source: Center for Watershed Protection.



Typical Constructed Wetland Schematic. Source: Center for Watershed Protection.

Siting

Space Requirements

- Drainage area – Can treat up to 100 acres, depending on the design. Check local and state guidelines: some regulations set a ratio of drainage area to pond area.
- Footprint (assuming ~100% impervious): 2–3% of drainage area for ponds and 3–5% for wetlands (MPCA)
- Excavation depth from existing ground surface: 3-10 ft typical

Location

- Ponds and wetlands can be used to treat drainage areas that contain scrap storage and processing operations.
- Ponds and wetlands should be placed at a low point in the drainage area and near a discharge point to surface waters.
- Pervious surfaces can be included in the drainage area, but any chronic erosion should be stabilized to reduce sediment deposition and maintenance burdens.
- Do not place unlined basins in areas with a shallow depth to groundwater or with highly porous subgrade (e.g., Karst, construction debris).
- For new or expanded facilities, wetlands and ponds can be incorporated into an overall stormwater management system.

Design

Considerations for Scrap Recycling Facilities

- **Pretreatment** – A forebay is recommended in order to remove coarse to medium-sized particles (down to approximately 0.25 mm) through rapid settling. Larger debris can also be captured, while smaller particles will generally pass through to the basin. The forebay should be easily accessible for maintenance (primarily consisting of sediment and debris removal).

- **Small particles –** Particles smaller than approximately 50 µm will be difficult to remove through settling alone without interception (MPCA). One option to remove small particles and assist in meeting effluent targets is to oversize the basin or pond, or place a filter system upstream or downstream of the basin or pond. Another option is chemical precipitation through coagulation and flocculation (mechanisms employed in water treatment processes). Some states restrict the use and disposal of chemical additives.

Design Elements and Guidelines for Basins, Ponds, and Wetlands

Design Element	Notes
Forebay	• Approximately 10% of total water quality volume (basin or pond) • 10-15% of the total surface area (wetland) • Typically 2.5 ft. or deeper
Liner	• Desirable to reduce groundwater impact risk • 6-12 in. of clay soil • Impermeable liner
Pond Configuration	• 1.5:1 minimum length to width ratio (check state guidelines) • Surface area: 2-3% of catchment area at a minimum
Wetland Configuration	• 2:1 minimum length to width ratio (check state guidelines) • Surface area: 3-5% of catchment area at a minimum
Side slopes	• Maximum of 3H:1V
Chemical precipitation	• Not recommended for wetlands; may be suitable for wet ponds • Can occur in a large forebay or in the basin itself. • The chemical treatment should be applied to a significant portion (50% or more) of the pond or basin volume. • Mixing can be provided by basin hydraulics or by an automated mechanical system, as needed. Chemical injection may help. • Choose an approach that minimizes the need for frequent sludge removal as well as control of pH and dosing. • Possible coagulants include ferric chloride, alum, and polymers (Price and Yonge 1995). • A simple jar test may be warranted for site-specific coagulant selection (Price and Yonge 1995). • A filter may be a more appropriate choice for removal of small particles if operations and maintenance is a concern. • State guidelines may limit the use of chemicals in surface water systems and specify disposal requirements for the precipitated sediments.

Forebay

The flows to the pond or wetland should first enter a forebay. The forebay allows for initial sediment deposition and for ease of maintenance as sediment deposits here instead of in the main pond or wetland area. The pond forebay should constitute 10% of the total water quality volume (NYSDEC, 2008). A wetland forebay is typically 10-15% of the total BMP area (Hunt et al., 2007). The forebay may be separated from the main section of the pond or wetland by a weir, channel, or berm.

Basins and Ponds

The water quality volume of the basin or pond may be specified in applicable regulations. A minimum of 50% of the water quality volume should be present in the permanent pool (NYSDEC, 2008). Long flow paths, multiple cells, and complex bottom topography and geometry enhance water quality treatment performance and should be incorporated as possible. A minimum recommended length to width ratio should be 1.5:1. The minimum surface area to drainage area should be 2-3%. Check your state guidelines – the required ratios may vary.

Vegetation should be planted along the embankments and edges of the pond. Vegetation should also be planted in the pond itself if possible. A maintenance access road should be included to facilitate sediment removal from the forebay and other parts of the pond. The outlet riser pipe/orifice should be non-clogging and a trash rack should be installed on the outlet spillway.

Wetlands

Long flow paths should also be employed for wetlands. Specifically, a minimum 2:1 length to width ratio should be used to maximize contact time in the wetland. Micro topography should be employed to enhance habitat diversity. Twenty five percent of the water quality volume should be in deep water, greater than 2.5 feet in depth. The other 65% of the wetland should be shallower than 18 inches in depth, with a minimum of 35% of the pond being six inches or less (NYSDEC, 2008). A micropool should be present at the outlet to prevent clogging. The wetland planting plan should address vegetation for a significant portion of the pooled areas, embankments, and buffer areas around the wetland. Topsoil may be added to the final, graded wetland surface to promote vegetative growth.

Liners

An impermeable liner will keep water from the pond or wetland from leaching into the underlying groundwater or aquifer. This is of particular concern when pollutants are present which could impact the groundwater resource. Liners can be constructed by compacting 6-12 inches of clay soil or by using an impermeable geotextile liner (NYSDEC, 2008).

Conveyance

Stormwater can be diverted to the basin, pond, or wetland as overland flow or from the existing stormwater infrastructure. Overland or sheet flow into the pond or wetland is the least expensive option and should be considered first if possible. Erosion at the basin, pond, or wetland inlet must be considered; however, erosive flows are mitigated in the forebay to some degree.

Outflows from the system should be directed to the existing stormwater infrastructure or to the nearest natural drainage outlet. An emergency overflow should be installed to accommodate any storms larger than the design storm. The outlet pipes should route effluent into the drainage system or surface water such that erosion will not occur. If discharging to a natural outlet, rip rap protection, flared pipe outlets, and/or level spreaders should be used as necessary to prevent erosion.

Sizing

The area of the wetland or pond and the permanent pool depth will be controlled by the size of the water quality storm, catchment area, and available land. Pond and wetland sizing is also affected by the rainfall pattern at the site, and the watershed characteristics (such as land use and soils). The area of pond required per area of watershed is generally 2-3%, and is 3-5% for wetlands (MPCA).

Cost

The planning-level construction cost is based on *Urban Stormwater Retrofit Practices, Version 1.0*, Appendix E (CWP 2007), and is expressed as cost per acre of impervious surface treated, assuming one inch of rainfall . Costs were adjusted from 2006 to January 2017 U.S. dollars using the Engineering News-Record Construction Cost Index. Median, 25th percentile, and 75th percentile costs are provided for consistency with the original source. The 75th percentile cost is recommended as a basis for planning purposes, however. The construction cost may be somewhat lower if retrofitting an existing pond to enhance performance. Models such as WinSLAMM have a cost module.

Planning-Level Construction Cost (2017 $ per Acre Impervious Treated)

Detention Type	25th percentile	Median	75th percentile
Basin/Pond/Wetland	$12,000	$23,000	$46,000

Maintenance Requirements

Frequency	Activity
After Construction	• Inspect drainage system to ensure functionality
Semi Annual, more frequent if needed	• Inspect inlet/outlets for clogging, excess sediment buildup, bank stability, vegetation, trash and debris, locations of erosion
Annual	• Inspect for excess forebay sediment, upstream/downstream erosion, algal growth, oil sheens, discolorations, odors
3-4 Times per Year	• Trash and debris removal, bank vegetation mowing
If necessary after 1st year of planting	• Wetland Plants Replanting
Every 5-7 years or at 50% of forebay volume	• Sediment Removal from forebays and micropools
Every 5-7 years	• Harvest wetland plants to determine if density/thickness will cause flooding or detrimental flow conditions

Source: CSQA, 2003

References

California Stormwater Quality Association (CSQA), Stormwater Best Management Practice Handbook Industrial and Commercial, 2003.

Center for Watershed Protection. (2007). “Urban Subwatershed Restoration Manual Series, Manual 3: Urban Stormwater Retrofit Practices, Version 1.0”

Hunt, W.F., Burchell, M.R., Wright, J.D., Bass, K.L. (2007).”Urban Waterways: Stormwater Wetland Design Update: Zones, Vegetation, Soil, and Outlet Guidance.” North Carolina Cooperative Extension Service, Raleigh, NC. Available at http://www.bae.ncsu.edu/stormwater/PublicationFiles/ WetlandDesignUpdate2007.pdf. Retrieved online 25 Feb. 2011.

Minnesota Pollution Control Agency (MPCA), Industrial Stormwater Best Management Practices Guidebook.

New York State Department of Environmental Conservation (NYSDEC), New York State Stormwater Management Design Manual, April 2008.

Price, F.A., Yonge, D.R. (1995). "Enhancing Contaminant Removal In Stormwater Detention Basins by Coagulation." Washington State Department of Transportation, Olympia, WA. Available at http://www.wsdot.wa.gov/Research/Reports/300/358.1.htm. Retrieved online 25 Feb. 2011.

Water Environment Research Foundation. (2008). "Analysis of Treatment System Performance: International Stormwater Best Management Practices (BMP) Database, 1999-2008." Available at http://www.bmpdatabase.org/Docs/Performance Summary June 2008.pdf. Retrieved online 10 Feb. 2011.

Filtration System Profile

Description

A filtration system is an above- or below-ground device that combines a pretreatment area and a media filter bed. Media filters build on sand filter designs by using an engineered media mixture (as opposed to simply sand) to maximize the removal of facility-specific pollutants. With proper pretreatment, media filters can be used to treat runoff in numerous locations throughout scrap recycling facilities, including scrap storage areas. They may also be incorporated into an overall stormwater management system for new or expanded facilities.

The primary benefit of media filters is effective removal of sediment and metals through a variety of chemical and physical processes. They also provide hydrologic remediation by capturing and detaining runoff from small, frequently-occurring events. Larger events are either bypassed or safely conveyed through the system. Media filters are typically watertight, preventing infiltration of industrial runoff into the subsurface soil and reducing the risk of groundwater impacts.

Benefits and Limitations

- **(+)** Adaptable to a wide variety of site configurations
- **(+)** Good to excellent removal of particulate and some filterable pollutants
- **(+)** Underground filters can be used in space-constrained sites
- **(+)** Precast concrete components are available for some designs

- **(-)** Regular maintenance needed to maintain acceptable permeability

(-) Underground components require specialized training and equipment for maintenance

(-) Use of underdrain requires suitable connection to storm drain infrastructure

(-) May pose groundwater impacts risk if not watertight

Performance

Media filters achieve good to excellent water quality performance through unit processes that include sedimentation, filtration, chemical sorption, and microbial action. Media filters can remove a wide range of particle sizes, from grit to very small (3 µm) particles (Pitt and Clark 2010). Good removal of filterable constituents has been observed, although results may vary. As with sedimentation devices, the effectiveness of filtration systems is dependent on the influent concentrations, and the effluent concentrations shown below are not guaranteed.

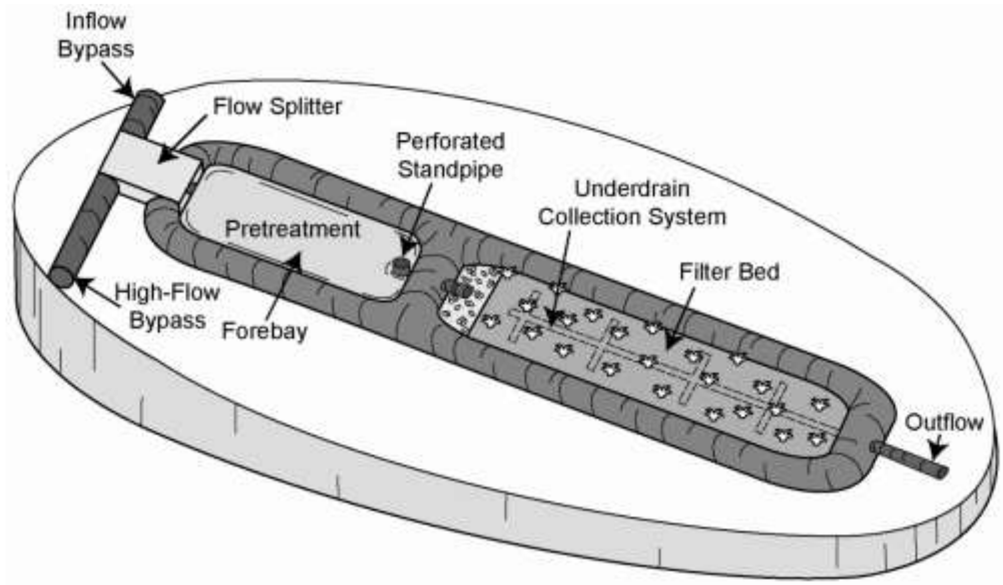
Presented below is the expected range of water quality performance of a media filtration system showing the low, high, and median values for annual mass % removal and effluent concentrations. Annual mass removals are referenced from the *Urban Stormwater Retrofit Practices, Version 1.0* (CWP, 2007), where low and high represent the 25th and 75th percentiles of the compiled data. Effluent concentrations are referenced from the *International Stormwater BMP Database* (WERF, 2008, updated 2015), where low and high represent the bounds of the 95th confidence interval.

Temporary surface ponding, infiltration through media, and storage in media pores provide moderate reductions in the peak flow rate. If constructed as part of a larger basin, media filters can also provide peak rate control through detention. Volume reduction may occur but is generally not substantial.

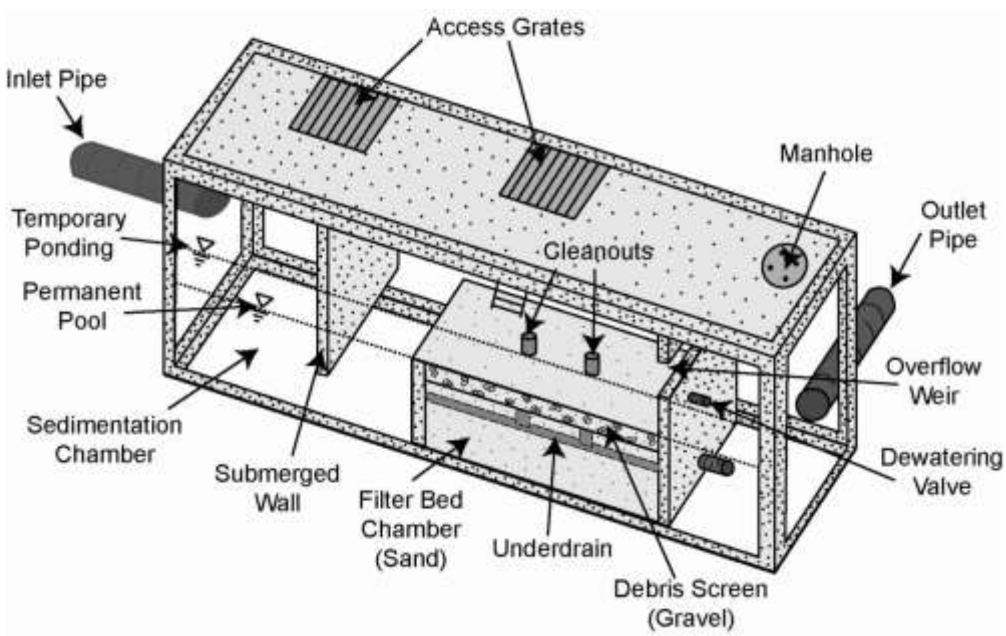
Media Filter Water Quality Performance

Performance		TSS	Pb	Cu	Zn
Annual mass removal (%)	Median	85	-	40	90
	Low	80	-	35	70
	High	90	-	70	90
Effluent concentration	Median	16 mg/L	3.8 µg/L	10 µg/L	38 µg/L
	Low	9.7 mg/L	1.1 µg/L	8.2 µg/L	17 µg/L
	High	22 mg/L	6.4 µg/L	12 µg/L	58 µg/L

Source: Center for Watershed Protection; WERF



Typical Surface Media Filter Schematic. Source: Center for Watershed Protection.



Typical underground media filter schematic. Source: Center for Watershed Protection.

Peat Media Filter

Siting

Space Requirements

- Drainage area – Can treat between 1 and 10 acres, depending on the design
- Footprint (assuming ~100% impervious): 1**–**3% of drainage area
- Excavation depth from existing ground surface: 4–6 ft typical

Location

- Media filters can be used to treat drainage areas that contain scrap storage and processing operations.
- Consider the placement of media filters relative to other stormwater treatment and conveyance elements to allow a treatment train approach.
- Due to clogging concerns, do not place media filters within drainage areas that are prone to erosion or where sediment generation is high. In general, pervious surfaces should be kept out of the media filter drainage area.
- For new or expanded facilities, media filters can be incorporated into an overall stormwater management system.

Design

- **Pretreatment –** Pretreatment must be provided for media filters at scrap recycling facilities and are a standard feature of most media filter designs. Coarse to medium-sized particles can be removed through rapid settling in a forebay or sedimentation chamber. Smaller particles will generally pass through to the filter bed. Pretreatment areas should be easily accessible for maintenance (primarily sediment and debris removal).

- **Media** – The water quality performance and operating life of an engineered media mixture is generally superior to plain sand (Pitt and Clark 2010). A mixture of sand, ion exchange media, and organic material is recommended to meet water quality targets for scrap recycling facilities. The organic material used will depend on local availability and effluent standards.

Typical design criteria are listed below. Local standards may stipulate certain aspects of the design, such as pretreatment design, water quality volume formula, and presumptive pollutant removal.

Media Filter Design Elements and Guidelines

Design Element	Notes
Pretreatment configuration (forebay or chamber)	• If a pond: 2 ft minimum pond depth • Minimum recommended length-to-width ratio of 2.0 for surface and underground filters; n/a for perimeter filters
Side slopes	• Maximum 3:1 horizontal to vertical
Media	• Thickness = 18 in. minimum; 3 ft. preferred • Equal parts by volume of sand, ion exchange media, organic material • Sand: Moderately fine-grained (e.g., rhyolite sand), approx. 1 mm to 0.2 mm particle size. The sand acts as a filter, provides structure to media, and modulates the flow rate and contact time. • Ion exchange media: zeolite, perlite, or similar • Organic material: To meet stringent effluent limits, granular activated carbon is recommended. In other cases, compost or peat moss may be used. • Depth of media can affect performance • Media should be mixed thoroughly, not layered • Flow rate through media of 0.75–8.0 ft/hr
Underdrain	• Required in most cases • Perforated or slotted sch. 40 PVC within filter bed; solid elsewhere

Design Element	Notes
	• 4-6 in. diameter • Use solid vertical PVC for inspection/observation well. Place at start and end of perforated section and elsewhere as needed
Underdrain gravel	• 0.5–1.5 in. clean broken stone (AASHTO M-43), washed • Min 2 in. stone above and below underdrain pipe
Liner	• Pond liner or equivalent • Minimum 30 mil thick liner • Use felt or geotextile underlayment to prevent puncture
Filter fabric	• Placed between media layer and underdrain gravel • Nonwoven polypropylene, min. permeability 110 gal/min/sq. ft.
Vegetation	• Surface media filters may have a top layer of 3 in. topsoil and turf
Depth to groundwater	• Media filters are typically watertight, in which case there is no restriction on depth to groundwater • Check restrictions in stormwater permit and state guidelines
Utilities	• Maintain minimum 3 ft. horizontal separation from natural gas and communications lines, and 5 ft. separation from water lines. Do not place a media filter above these utilities.
Offsets	• Overflow should be directed away from structures and neighboring properties.

Conveyance

Media filters can accept all types of inflow, from sheet to piped flow. Pretreatment is required to prevent clogging the filters.

Media filters can be designed as online or offline devices. Offline designs are the most common and are recommended where feasible. Offline media filters only receive flows which can be treated in the system per the design specifications. Runoff in excess of the design specifications continues down the main flow path.

In online devices, all flows enter the media filter. An overflow structure must be provided in online devices to safely convey all flows in excess of the design event, up to a maximum event as specified by local guidance. An overflow structure may consist of an inline drain, a yard inlet, a weir, or other device. The pipe or channel receiving the overflow must be non-erosive and adequately sized.

Underdrains require a suitable outfall or tie-in location. Options include catch basins, manholes, stable channels, vaults, and ponds. A connection to a storm drain (e.g., with flexible tap saddle) can be made, but additional inspection and hydraulic analysis is recommended to prevent backflow into the system.

Design Variants

The most common types of media filter are surface, underground, and perimeter. Underground and perimeter media filters have a permanent pool in the pretreatment area (sedimentation chamber). Surface media filters typically have only a temporary pool in the pretreatment area. The top of the filter bed may be grassed or vegetated in surface designs.

Sizing

- Typically, media filters are sized to contain 75–100% of the water quality volume (WQv), distributed between temporary storage in the pretreatment area and the filter bed.

- Pretreatment
  - Volume – Typically 25% of design volume, excluding permanent pool if present
  - Surface area sizing equation – WQv * 0.25 / (Pretreatment temporary ponding depth)

- Filter bed
  - Volume – Typically 75% of design volume (depending on storage in pretreatment)
  - Provide temporary ponding above filter bed. Vertical constraints may limit total depth.
  - Surface area – Approximately 1–2% of drainage area; refer to local guidance

Cost

The planning-level construction cost is based on *Urban Stormwater Retrofit Practices, Version 1.0*, Appendix E (CWP 2007), and is expressed as cost per acre of impervious surface treated, assuming one inch of rainfall. Costs were adjusted from 2006 to January 2017 U.S. dollars using the Engineering News-Record Construction Cost Index. Median, 25th percentile, and 75th percentile costs are provided for consistency with the original source. The 75th percentile cost is recommended as a basis for planning purposes, however. Costs are provided for surface and underground media filters.

Planning-Level Construction Cost (2017 $ per Acre Impervious Treated)

Retrofit type	25th percentile	Median	75th percentile
Surface media filter	$75,000	$100,000	$105,000
Underground media filter	$140,000	$320,000	$365,000

Maintenance Requirements

Frequency	Activity
Every three months, and after large events	• Prior to any work, allow filter bed to draw down and partially dry. Pump out any permanent pools. • Remove large debris and litter throughout system. • Remove sediment deposits from the pretreatment area when they have accumulated more than six inches, and from the filter bed when they have accumulated more than one inch. • Inspect fix erosion or scouring in drainage area, side slopes if present, and filter surface. Filter surface should be repaired with original material only.
Every six months	• Remove oil and floating debris from pretreatment areas.
Every year	• Inspect structural components (e.g., concrete) for deterioration.
Maintaining permeability	• The drain time from the maximum ponding depth should be observed and recorded twice annually at a minimum. • If drain time slows to about 72 hours, inspect and correct for clogging in the underdrain or elsewhere in conveyance system. • If the problem persists, remove the top 2–6 inches of filter media and replace with clean media.
Vegetation maintenance	• Mow grass monthly during growing season; weed as needed. • Do not fertilize media filters. • Use herbicide as a last resort only. Herbicide must be approved for use in streams and wetlands. • Remove plant cuttings from media filter; compost if feasible.
Personnel and operations	• Most above-ground maintenance tasks can be performed by site personnel. • Below-ground maintenance requires appropriate training and equipment.

References

Atlanta Regional Commission. (2001). “Georgia Stormwater Management Manual, Volume 2: Technical Handbook.” Atlanta, GA. Available at http://www.georgiastormwater.com. Retrieved online 8 Feb. 2011.

Center for Watershed Protection. (2007). “Urban Subwatershed Restoration Manual Series, Manual 3: Urban Stormwater Retrofit Practices, Version 1.0”

Maryland Department of the Environment (MDE). (2009). Maryland *Stormwater Design Manual, Volumes I & II (Effective October 2000).* MDE, Baltimore, MD. Available at http://www.mde.state.md. us/programs/Water/StormwaterManagementProgram. Retrieved online 8 Feb. 2011.

New Jersey Department of Environmental Protection (NJDEP). (2009). New Jersey Stormwater Best Management Practices Manual. NJDEP, Trenton, NJ. Available at http://www.njstormwater.org. Retrieved online 8 Feb. 2011.

Pitt, R., Clark, S.E. (2010). "Evaluation of Biofiltration Media for Engineered Natural Treatment Systems." Geosyntec Consultants, Santa Barbara, CA.

Water Environment Research Foundation. (2008). "Analysis of Treatment System Performance: International Stormwater Best Management Practices (BMP) Database, 1999-2008." Available at http://www.bmpdatabase.org/Docs/Performance Summary June 2008.pdf. Retrieved online 10 Feb. 2011.

Biofilter Profile

Description

A biofilter (also referred to as a bioretention system) utilizes plants and engineered media to treat runoff. Biofilters are most suitable for treatment of runoff from parking lots, rooftops, and other non-scrap storage areas. They may also be incorporated into an overall stormwater management system for new or expanded scrap recycling facilities.

Biofilters effectively remove stormwater pollutants through a variety of chemical, physical, and biological processes. Hydrologic impacts are also mitigated by capturing and detaining runoff from small, frequently-occurring events. Larger events are bypassed or safely conveyed through the system. Biofilters are not continuously "wet" systems; rather, they are designed to mimic dry upland environments and drain relatively quickly. They may include an impermeable liner to prevent infiltration of industrial runoff.

Benefits and Limitations

(+) Good to excellent removals for particulate (and some filterable) pollutants

(+) Little specialized maintenance required – minimal confined space entry

(+) Prevents runoff from reaching active portions of scrap recycling facility

(+) Provides low-maintenance green space that may be incorporated into new facility designs

(-) At existing facilities, applicability limited to areas not used for scrap storage or processing

(-) Partial or full media replacement may be needed after 10 years (depending on inlet loading)

(-) Underdrain is typically needed, requiring suitable connection to storm drain infrastructure

(-) May pose risk of groundwater impacts if not lined

(-) May leach nutrients from media into effluent flow

Performance

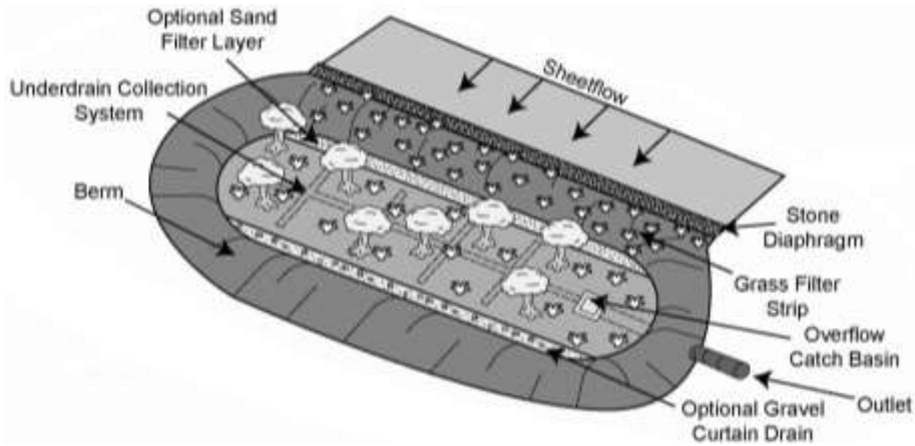
Biofilters achieve good to excellent water quality performance through unit processes that include sedimentation, filtration, chemical sorption, and biological activity (plant uptake, microbial action). Temporary surface ponding, infiltration through media, storage in media pores, and evapotranspiration combine to mitigate hydrologic impacts. Infiltration into the subsoil will generally not be significant at scrap recycling facilities and may be inadvisable. Biofilters effectively reduce peak flow rates, time to peak, and outflow volume for smaller events.

Presented below is the expected range of water quality performance of the biofilter, presenting the low, high, and median values for annual mass % removal and effluent concentration. Annual mass removals are referenced from the *Urban Stormwater Retrofit Practices, Version 1.0* (CWP, 2007), where low and high represent the 25th and 75th percentiles of the compiled data. Effluent concentrations are referenced from the *International Stormwater BMP Database* (WERF, 2008), where low and high represent the bounds of the 95th confidence interval.

Biofilter Water Quality Performance

Performance		**TSS**	**Pb**	**Cu**	**Zn**
Annual mass removal (%)	Median	60	-	80	80
	Low	15	-	40	40
	High	75	-	95	95
Effluent concentration	Median	24 mg/L	6.7 µg/L	11 µg/L	40 µg/L
	Low	15 mg/L	2.8 µg/L	7.7 µg/L	28 µg/L
	High	33 mg/L	11 µg/L	14 µg/L	52 µg/L

Source: Center for Watershed Protection; WERF



Typical Biofilter Schematic. Source: Center for Watershed Protection.

Siting

Space Requirements

- Excavation depth from existing ground surface: 3.5 – 4.5 ft typical. Above-ground planters may be an option for roof runoff or other settings, reducing or eliminating the need for excavation.
- Drainage area: Typically up to 0.5 ac impervious. Multiple biofilters can be distributed through larger areas.
- Footprint (assuming ~100% impervious): 5% or more of drainage area. Some state guidelines set the ratio.

Location

- At existing scrap recycling facilities, biofilters are best suited to treat runoff from relatively clean areas that are not used to store or process scrap
- Biofilters should be placed adjacent to non-scrap areas. To avoid the expense of pavement removal, construct the biofilter in a pervious or unpaved surface (such as a parking lot median).
- Biofilters are placed slightly lower in elevation than the surrounding surfaces to allow positive drainage to the system.
- Placing biofilters upstream of other stormwater treatment and conveyance elements, such as catch basins or vaults, will facilitate a treatment train approach and simplify underdrain tie-in.
- Do not place biofilters within drainage areas that are prone to chronic erosion or in areas with a shallow depth to groundwater.
- For new or expanded facilities, biofilters can be incorporated into an overall stormwater management system

Design

- **Pretreatment –** Pretreatment is recommended for all biofilters at scrap recycling facilities. Grass filter strips can be used to encourage sheet flow if low pollutant loadings are present (space permitting). In most cases, a stone-lined or concrete forebay will be most appropriate. Provide surface roughness (e.g., stones) to encourage sedimentation and reduce scour. Pretreatment areas should be easily accessible for maintenance, primarily sediment and debris removal. Pretreatment areas can also assist in evenly distributing inflow and reducing its energy.

- **Vegetation –** Selected vegetation must withstand harsh conditions and occasional maintenance. Native vegetation will be best suited to naturally cope with seasonal climate variations in the region (e.g., dry summers and rainy/snowy winters).

Biofilter Design Elements and Guidelines

Typical design specifications are listed below. Local standards may stipulate certain aspects of the design, such as media mix, water quality volume formula, and presumptive pollutant removal. Field studies indicate operating lifetimes of 10 years or greater for biofilters; however, clogging may occur before treatment capacity is exhausted (soil “saturated” with pollutants). Appropriate biofilter placement, periodic sediment removal, and semi-annual mulch replacement will mitigate the formation of pollutant hotspots in the media.

Design Elements and Guidelines for Biofilters

Design Element	Notes
Ponding depth	• 6 - 9 in. from mulch surface to overflow elevation
Side slopes	• Max 3:1 if vegetated • 3:1 horizontal to vertical if non-erodible or hardscape
Mulch	• 3 in. aged, double-shredded hardwood (may be reduced once vegetation is established)
Biofiltration Media	• Engineered media, classified as "sandy loam" or "loamy sand" • 2-4 ft. deep typical • Drawdown rate controlled by media; max. 24-48 hr for full drawdown is typical • Total clay content < 5% • Refer to local regulations for specific mix
Underdrain	• In the absence of tests that demonstrate adequate infiltration capacity in the existing soil (at least 0.25 in/hr), an underdrain must be provided to ensure positive drainage. • 4-6 in. diameter, perforated or slotted sch. 40 PVC • Use solid vertical PVC for inspection/observation well. Place wells at start of underdrain and every 50 ft.
Underdrain gravel	• #57 **–** Min. 3 in. bedding below underdrain. Extend to top of underdrain. Stone must be washed. • #7 **–** 3 in. layer between #57 and media. Stone must be washed.
Liner	• Pond liner or equivalent, minimum 30 mil thickness • Use felt or geotextile underlayment to prevent puncture. • Do not place geotextile between media and underdrain.
Vegetation	• Salt-tolerant • Native plants preferred for greater hardiness • Able to withstand prolonged dry periods and brief inundation
Depth to groundwater	• Biofilters constructed with an impermeable liner have no restriction on depth to groundwater as long as it is below the liner. • In unlined systems, maintain min 2 ft. vertical separation between bottom of excavation and top of seasonally high groundwater table to minimize the potential for groundwater impacts.

Offsets	• Maintain minimum 3 ft. horizontal separation from natural gas and communications lines, and 5 ft. separation from water lines. Do not place a biofilter above utilities.
	• Offsets for unlined systems:
	  ○ 10 ft. from building foundation
	  ○ 10 ft. (min) from the start of a steep slope
	• Overflow should be directed away from structures and neighboring properties.

Conveyance

Acceptable types of inflow are sheet flow, shallow concentrated flow, and pipe flow from a flow splitter. Provide pretreatment in all cases (see above). Biofilters can be designed as online or offline devices. Offline biofilters are placed parallel to the main flow path and are recommended where appropriate. In offline designs, excess flows bypass the biofilter and continue down the original conveyance when the maximum ponding depth is reached.

In online devices, all flows enter the biofilter. An overflow structure must be provided in online devices to safely convey all flows in excess of the design event, up to a maximum event as specified by local guidance. An overflow structure may consist of an inline drain, a yard inlet, a weir, or other device. The pipe or channel receiving the overflow must be non-erosive and adequately sized.

Underdrains require a suitable outfall or tie-in location. Options include catch basins, manholes, stable channels, vaults, and ponds. A connection to a storm drain (e.g., with flexible tap saddle) can be made if needed, but additional inspection and hydraulic analysis is recommended.

Design Variants

Tree box filters are a proprietary biofilter which may be appropriate for use if properly sized.

Above-ground planters can be considered for roof runoff or areas with an abrupt change in grade, reducing or eliminating the need for excavation. This approach may also simplify conveyance by allowing discharge to a surface channel instead of connecting to subsurface drainage infrastructure.

Sizing

Media depth and the amount of ponding desired influence biofilter sizing. Use a 3 foot media depth where feasible. Typical biofilter footprints range from 5 to 10% of the drainage area depending on site conditions and local design standards. Additional area is needed to accommodate side slopes (1-2 feet horizontally around biofilter perimeter) and pretreatment. Undersizing a biofilter may cause damage and/or poor water quality performance due to high hydraulic loadings. Careful attention to conveyance and pretreatment design may mitigate some effects of undersizing.

Cost

The planning-level construction cost is based on *Urban Stormwater Retrofit Practices, Version 1.0*, Appendix E (CWP 2007), and is expressed as cost per acre of impervious surface treated, assuming one inch of rainfall. Costs were adjusted from 2006 to January 2017 U.S. dollars using the Engineering News-Record Construction Cost Index. Median, 25th percentile, and 75th percentile costs are provided for consistency with the original source. The 75th percentile cost is recommended as a basis for planning purposes, however. Costs are provided for in-ground biofilters and for above-ground planters.

Planning-Level Construction Cost (2017 $ per Acre Impervious Treated)

Retrofit type	25th percentile	Median	75th percentile
Biofilter (in-ground)	$35,000	$50,000	$80,000
Planter (above-ground)	$90,000	$135,000	$175,000

Maintenance Requirements

Frequency	Activity
Monthly, and after large events (more than 3.5 in. rain in 24 hours)	• Remove sediment, debris, and litter from pretreatment area, biofilter surface, side slopes, and inflow and outflow points. • Inspect and correct erosion or scouring in drainage area, side slopes, and biofilter surface. Biofilter surface should be repaired only with original mulch, cobble, or filter media. • Inspect and correct underdrain or media clogging if ponding regularly persists after 48 hours.
Each spring	• Cut previous year's growth back to 6 in. height, excluding woody plants. • Restore mulch to design depth if biodegradation has occurred. Replace mulch as needed. • Remove weeds. Weed more frequently as needed. • Inspect for and replace dead or diseased vegetation.
Vegetation maintenance	• Do not fertilize biofilters. • Use herbicide as a last resort only. Herbicide must be approved for use in streams and wetlands and have a short half-life. Use glyphosate herbicide (e.g., Accord, Rodeo). • Remove plant cuttings from biofilter; compost if feasible. • Watering is not necessary except in drought conditions (three weeks or more without rain). In droughts, provide at least one inch of water per week at the end of the day. • Avoid using biofilters for snow storage if possible.
Personnel and operations	• Maintenance tasks can be performed by site personnel. • A landscape contractor can be used for annual inspection and maintenance if desired.

References

Center for Watershed Protection. (2007). “Urban Subwatershed Restoration Manual Series, Manual 3: Urban Stormwater Retrofit Practices, Version 1.0”

Davis, A.P. (2007). “Field Performance of Bioretention: Water Quality.” *Environ. Eng. Sci.,* 24(8), 1048-1064.

DiBlasi, C.J., Li, H., Davis, A.P., Ghosh, U. (2009). “Removal and Fate of Polycyclic Aromatic Hydrocarbon Pollutants in an Urban Stormwater Bioretention Facility.” Environ. Sci. Technol., 43(2), 494–502.

Hong, E., Seagren, E.A., Davis, A.P. (2006). “Sustainable Oil and Grease Removal from Synthetic Stormwater Runoff Using Bench-Scale Bioretention Studies.” Water Environ. Res., 78(2), 141-155.

Lake County, Ohio. (2005). “Bioretention Guidance: Lake County, Ohio.” Available online.

Transportation Research Board. (2006). “Low Impact Development Design Manual for Highway Runoff Control (LID Design Manual).” Washington, DC.

Water Environment Research Foundation. (2008). “Analysis of Treatment System Performance: International Stormwater Best Management Practices (BMP) Database, 1999-2008.” Available at http://www.bmpdatabase.org/Docs/Performance Summary June 2008.pdf. Retrieved online 10 Feb. 2011.

Multi-Chambered Treatment Train (MCTT) Profile

Description

A multi-chambered treatment train (MCTT) is a series of two or more chambers used to remove pollutants from stormwater. The first chamber is typically a catch basin or similar sedimentation device that is designed to screen large materials and promote settling of solids. A second chamber may be the main settling basin, where settling is enhanced by tube settlers placed at angles near the bottom of the chamber. Floating sorbent pillows in this chamber capture floating oil and grease. A third chamber may contain an ion exchange/media filter consisting of sand, peat, zeolite, and/or activated carbon. The filter provides removal of filterable constituents. The third chamber may also incorporate chemical treatment or other advanced polishing system. Overall, the MCTT employs a combination of screening, settling, sorption, ion exchange, filtration, and/or chemical treatment, and has been shown effective at removing both particulate and filterable constituents in stormwater. As the MCTT has not been installed at full scale in many locations, performance data and cost estimations for full scale systems are limited.

Benefits and Limitations

(+) Underground storage and treatment of stormwater for space constrained sites

(+) High reduction of suspended solids, phosphorous, zinc, lead, and toxicants

(+) Pilot and full scale systems shown effective on sites with vehicle maintenance and storage

(-) Higher cost than other many other treatment systems

(-) Little contractor experience with installation, no pre-fabricated systems

(-) Maintenance of chamber components required

(-) Only a few systems installed and monitored to serve as a guide for designers

Performance

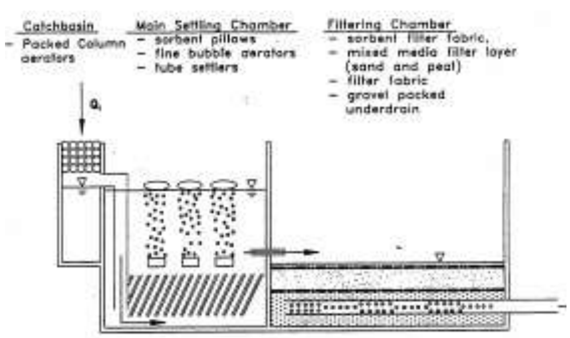
MCTTs provide removal of suspended and filterable stormwater pollutants via screening, settling, ion exchange, and filtration. In general, suspended solids are removed in the settling process and filterable solids are removed in the ion exchange and filtration processes. The screening process serves mostly to lower maintenance requirements for the final treatment chamber(s).

Presented below is the expected range of water quality performance of the MCTT, showing the low, high, and median values for estimated annual mass % removal and effluent concentration. Annual mass removals and effluent concentrations are referenced from a U.S. Environmental Protection Agency study (Pitt et al., 1999) that documented results from a pilot scale and two full scale installations.

MCTT Water Quality Performance

Performance		TSS	Pb	Cu	Zn
Annual mass removal (%)	Median	85	n/a	65	91
	Low	83	93	15	90
	High	98	96	90	91
Effluent concentration	Median	5.5 mg/L	< 2 µg/L	15 µg/L	18 µg/L
	Low	< 5 mg/L	1.8 µg/L	3 µg/L	15 µg/L
	High	10 mg/L	< 3 µg/L	15 µg/L	< 20 µg/L

Source: Referenced from Corsi et al. (1999); Pitt



Schematic of MCTT (EPA 1999).

Siting

Space Requirements

- Drainage area – Performance has been verified for up to 2.5 acre drainage area
- Sizing based on targeted settling times and loading rates
- Site specific due to local rainfall intensity, duration, frequency, and catchment size

Location

- Best placed in locations with above-ground space constraints and few underground constraints (existing utility infrastructure, high groundwater table, etc.)
- Should be placed where stormwater runoff would be expected to contain high suspended solids concentrations and metals – “hot spots”.
- Should be placed in an area where maintenance access is not a problem.

Design

An understanding of particle size distributions and filterable constituents in the runoff will help the engineer design each chamber to capture a particular range of particle sizes and filterable factions. MCTTs are designed to remove the pollutants of concern on scrap facilities: sediments, metals, and hydrocarbons. Due to the use of target hydraulic loadings and retention times for the chambers, designs will vary based on the local rainfall patterns and the magnitude of pollutant removal desired.

Typical design for a three-chamber system:

- **Catch Basin: First Chamber –** The catch basin will collect the largest suspended solids and other large debris. Floatables and other volatiles will also be sequestered. The size of this chamber should be designed to provide enough detention time to remove all floatables, large debris, and large suspended particles.

- **Settling Basin: Second Chamber –** The settling basin should be designed for a residence time between 1 and 3 days to facilitate removal of the majority of suspended solids.

- **Filter Media: Third Chamber –** The design of the filter media should be such that particle removal is optimized and maintenance of the filter media is minimized.

MCTT Design Elements and Guidelines (Typical)

Design Element	Notes
Target retention time in settling chamber	• 1 to 3 days
Target loading rate on filter	• 5 to 20 ft. per day
Media specifications	• 18 in. of peat • 54 in. of sand

Conveyance

Stormwater flow should be diverted to the MCTT as overland flow or from the existing stormwater infrastructure as the site conditions require. Overland or sheet flow into the MCTT should be the least expensive option and considered first. Erosion near the inlet and clogging of the inlet to the MCTT should be controlled. Outflows from the system should be directed to the existing stormwater infrastructure or to the nearest natural drainage outlet. The MCTT outlet elevation should be designed to allow positive drainage into surrounding conveyances. Overflows should also be directed to a conveyance channel or pipe infrastructure once the MCTT reaches capacity.

Sizing

Sizing of each chamber is the essential component of design. Considerations needed for sizing each component were discussed above in Design Elements and Guidelines.

Cost

The capital cost of a MCTT system, in January 2017 dollars, is estimated to range from $45,000-$90,000 per acre treated.

Maintenance and Inspection

Frequency	Activity
2 to 6 months	• Inspect and remove sediment accumulation in catch basin chamber and settling chamber
Every 1 to 2 years	• Replace packing balls in catch basin chamber • Replace hydrocarbon pillows in settling chamber • Replace or maintain media filter and perforated pipe • Replace filter fabric in media filter chamber

References

Center for Watershed Protection. (2007). "Urban Subwatershed Restoration Manual Series, Manual 3: Urban Stormwater Retrofit Practices, Version 1.0"

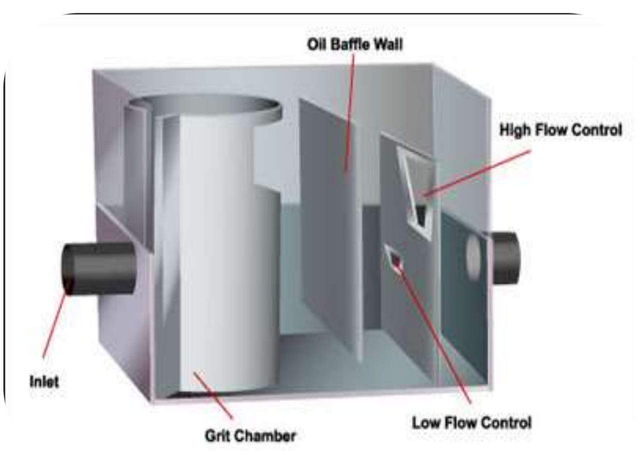
Corsi, S.R., S.R. Greb, R. T. Bannerman, and R. E. Pitt. (1999). "Evaluation of the multi-chambered treatment train, a retrofit water-quality management device." *Report 99-270*, U.S. Geological Survey, Middleton, Wisconsin.

Pitt, R.E., B. Robertson, P. Barron, A, Ayyoubi, and S. Clark. (1999). "Stormwater treatment at critical areas: the multi-chambered treatment train." *Report EPA/600/R-99/017*, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Enhanced/Modified Vault Treatment Profile

Description

Enhanced/modified vaults are designed to provide water quality improvement in addition to the conveyance and potential quantity control provided by standard vaults or sediment tanks. An example of an enhanced vault is an oil/water separator. Enhancements may include increasing the permanent pool to allow for increased sedimentation, use of baffles to increase flow paths (and separate debris / floatables), inclined plates to enhance surface area (for deposition of sediments), and oil/water separation for hydrocarbon removal.



Benefits and Limitations

(+) Underground storage and treatment of stormwater for space constrained sites

(+) Remove suspended particles, particulate-bound constituents, and hydrocarbons

(+) Reduce pollutant loadings in conveyance system and downstream BMPs

(-) Potential for sediment resuspension due to limited sump size

(-) Maintenance required for accumulated sediments

(-) Ineffective at removal of filterable pollutants/fine particles

Performance

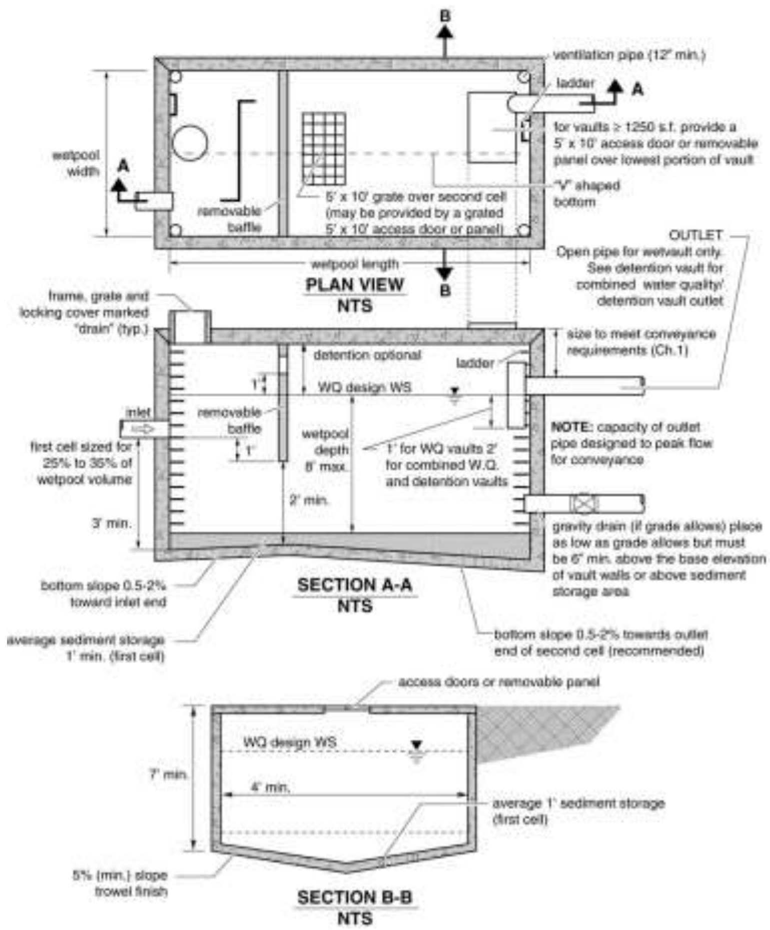
Enhanced/modified vaults improve water quality primarily through physical processes, including sedimentation and specific gravity separation. Chemical treatment is not a major feature of enhanced vaults. Peak control may be possible in some designs, but volume reduction will generally be negligible.

Presented below is the expected range of water quality performance of the enhanced/modified vault, showing the low, high, and median values of effluent concentration. For planning purposes, effluent concentrations are referenced from the performance data for hydrodynamic devices in the *International Stormwater BMP Database* (WERF, 2008), where low and high represent the bounds of the 95th confidence interval.

Enhanced/Modified Vault Water Quality Performance

Performance		TSS	Pb	Cu	Zn
Effluent concentration	Median	38 mg/L	11 µg/L	14 µg/L	80 µg/L
	Lower 95%	21 mg/L	4.3 µg/L	8.3 µg/L	53 µg/L
	Upper 95%	54 mg/L	17 µg/L	20 µg/L	108 µg/L

Source: Referenced from Corsi et al. (1999); Pitt



Stormwater Vault Details (Metro Council, 2001)

Siting

Space Requirements

- Typically for drainage areas of five acres or less (IDEQ, 2011)
- Size of vault varies based on desired storage volume

Location

- In areas where the water table is deep
- Twenty feet from buildings, property lines, septic tanks, 100 feet from domestic wells (IDEQ, 2011)
- Locations where above ground storage is not feasible
- Place at locations known as suspended solids source areas

Design

The vault is primarily effective for removal of suspended solids, particulate-bound metals, and hydrocarbons. Coarse to medium-sized particles (down to approximately 0.25 mm) can generally be removed through rapid settling. Removal of smaller particles (down to approximately 50 µm), with minimal losses through resuspension, may be possible depending on the design. Vaults may not be the preferred choice for removal of fine particles (<50 µm) or filterable constituents, although design enhancements could improve performance for some pollutants.

Enhanced / Modified Vault Design Elements and Guidelines

Design Element	Notes
Structural considerations	• Constructed of reinforced concrete • Minimum concrete strength of 3000 psi • Must be capable of supporting overhead loads from vehicles and equipment
Length to Width Ratio	• 3:1 or greater
Enhancements	• Depending on target pollutant, may include baffles, oil/water separator, inclined plates, and a permanent pool

Vault Design Elements and Guidelines

Vault systems are typically made of reinforced concrete. The reinforced concrete should have a minimum of 3000 psi strength. The structural strength of the vault should be such that vehicles, equipment, and overlying soil and pavement can be supported.

The vault consists of a forebay chamber separated from the main chamber by a baffle. Placing the outlet above the bottom of the vault allows permanent pool creation, enhancing pollutant removal. A length to width ratio of 3:1 or greater is recommended to maximize sedimentation (Metro Council, 2001). Maintenance ladders and manholes that allow access to the forebay, main chamber, and inlet/outlet pipes are needed.

Enhancements

Enhancements or modifications to the traditional vault design will be necessary to improve removal of hydrocarbons, filterable constituents, and nutrients. Additional enhancements will also improve suspended solids removal beyond the levels obtained with traditional vault structures. Enhancements may include: adding more baffles to increase flow paths (increased sedimentation), inclined plates to increase the amount of surface area (increased sedimentation), and oil/water separators (hydrocarbon removal).

Inclined plates enhance the amount of area available for particles to settle. This additional surface area within the water column allows minimization of the footprint of the structure. Lab and pilot studies have shown removals of greater than 65% of the suspended solids concentration when using inclined plates.

Conveyance

Stormwater flow may be diverted to the vault as overland flow or from the existing stormwater infrastructure. Overland or sheet flow into the vault is the least expensive option and should be considered first. Erosion near the inlet and clogging of the inlet to the vault should be carefully monitored and fixed if necessary. Outflows from the system should be directed to the existing stormwater infrastructure or to the nearest natural drainage outlet.

Pretreatment

Pretreatment is usually required for vault systems to remove trash and debris. If trash and debris are not removed before entering the vault inlet, clogging of the inlet or outlet pipes can occur. One option for pretreatment is a simple above ground trash rack at the inlet grate. Maintenance of the trash rack should be performed as not to impede stormwater from entering the system.

Sizing

The size of the vault depends on the local climate, runoff characteristics, and catchment area. Generally, water quality volume (as specified by local regulations) should be stored in a permanent pool. This will affect the length and width of the vault, and the placement of the outlet invert relative to the bottom of the vault. As storage volume decreases due to sediment accumulation in the vault, the design should consider the impact of reduced storage over time. Further, maintenance is essential to the vault providing consistent performance.

Maintenance and Inspection

Frequency	Activity
Every 1 – 6 months (site-specific)	• Inspect/Remove Floating Debris and Trash
	• Inspect/Remove Accumulated Sediments
	• Inspect/Remove Floating Hydrocarbons
	• Inspect Inlet Pipes/Outlet Pipes for Clogging

References

Clark, Shirley E., Roenning, Christopher D., Eligson, James C., and Mikula, J.B., Inclined Plate Settlers to Treat Storm-Water Solids, ASCE Journal of Environmental Engineering, Vol. 135, No. 8, 2009.

Idaho Department of Environmental Quality (IDEQ), Stormwater Best Management Practices Catalog, September 2005.

Metropolitan Council, Minnesota Urban Small Sites Best Management Practices Manual, 2001.

Minnesota Pollution Control Agency (MPCA), Industrial Stormwater Best Management Practices Guidebook.

Water Environment Research Foundation. (2008). "Analysis of Treatment System Performance: International Stormwater Best Management Practices (BMP) Database, 1999-2008." Available at http://www.bmpdatabase.org/Docs/Performance Summary June 2008.pdf. Retrieved online 10 Feb. 2011.

Proprietary Treatment System Profile

Description

Proprietary systems are commercially-available devices for stormwater treatment. In many cases, they can be tailored to the needs of industrial sites. Most proprietary treatment systems that would be appropriate for scrap recyclers involve stormwater detention/sediment removal, filtration, enhanced sediment vaults, and/or chemical treatment. Criteria for selecting a proprietary system may include space requirements, installation cost, maintenance frequency and cost, vendor support, and ability to meet water quality targets. Systems that have been used by scrap recyclers include hydrodynamic devices such as Vortech® and StormCeptor®, the ConTech StormFilter®, StormwateRx® systems, WaterTectonics®, the Hydro International Up-Flo Filter®, catch basin filters (Flo-Gard® by Kristar, Ultra-Urban® filter by AbTech Industries, and Triton® catch basin insert by ConTech), chemical treatment systems (coagulation – flocculation-sedimentation), oil/water separators, and many others.

Note: ISRI does not recommend or endorse any proprietary treatment system. The Phase II Study Team was aware that the above-listed systems have been used at scrap recycling facilities. Be skeptical of performance claims by manufacturers and distributors; request independent study results. Consider retaining a professional engineer or consultant to assist you in selecting, designing, and installing a treatment system.

ConTech StormFilter®   StormwateRx®

Benefits and Limitations

(+) Potential to remove a variety of particulate and some filterable pollutants

(+) Modular, thus a variety of configurations are available for new construction or retrofit

(+) Standardized and streamlined maintenance tasks

(+) Underground systems can be used in space-constrained sites

(-) Potential for dependence on proprietary replacement components (e.g., media) or maintenance

(-) Underground components require specialized training and equipment for maintenance

(-) Some systems require water to be pumped through the systems

(-) Regulator familiarity varies based on location

Performance

Proprietary systems improve water quality through numerous combinations of unit processes, including sedimentation, screening, filtration, sorption/ion exchange, and specific gravity separation. The combination of unit processes utilized by a given device varies based on the manufacturer's design. Performance data also varies by device and may be available from manufacturers. In proprietary water quality devices, incidental reductions in peak and volume may occur through temporary surface ponding and infiltration through media. Proprietary options for quantity control (e.g., vaults) are also available.

Siting

Space Requirements

- Drainage area – 0.5 to 5 acres as a general rule; consult manufacturer guidance
- Excavation depth from existing ground surface: 4 – 8 ft typical
- Commonly installed underground, minimizing the surface area needed for runoff treatment
- Footprint is dependent on product; refer to manufacturer guidance

Location

- Proprietary systems are typically subsurface devices, but above-ground products are also available.
- Proprietary systems can be used to treat drainage areas that contain scrap storage and processing operations.
- Consider the placement of proprietary systems relative to other stormwater treatment and conveyance elements to allow a treatment train approach.

Design

- **Pretreatment –** Pretreatment is recommended for all proprietary systems and is typically an integral element of such systems. Consult manufacturer guidance.

- **Media –** Specialized media for targeted pollutant removal are available from manufacturers. Media flow rates may also be optimized for a given system.

- **Design assistance –** Some manufacturers can offer design assistance for scrap recycling facilities, including guidance on meeting effluent targets.

Consult manufacturer design guidance for specific products. Several general guidelines are listed below.

Design Elements and Guidelines for Proprietary Systems

Design Element	Notes
Media	• A variety of proprietary, manufacturer-supplied media are available to target specific pollutants. Typical media components include sand, ion exchange media, and organic material.
Depth to groundwater	• Proprietary systems are typically watertight, thus there is no restriction on depth to groundwater.
Offsets	• Refer to manufacturer guidance. Typical offsets may include minimum 3 ft. horizontal separation from natural gas and communications lines, and 5 ft. separation from water lines. Do not place systems above utilities. • Offsets for unlined systems: o 10 ft. from building foundation o 10 ft. from the start of a steep slope • Overflow should be directed away from structures and neighboring properties.

Conveyance

While dependent on the product being evaluated, proprietary systems are generally compatible with a variety of types of inflow, including sheet flow, shallow concentrated flow, and piped flow. Offline or online configurations are available. Proprietary systems typically include a provision for high flow bypass. Some designs may require flows to be pumped.

Sizing

Sizing of proprietary systems is product-specific and manufacturer guidelines should be consulted. Some systems are sized on the basis of flow rate, while others are sized based on volume. In general, the water quality event (either rate or volume) and/or drainage area serviced are the basis for sizing proprietary treatment systems.

Cost

Cost is variable by product, consult manufacturer. A good treatment system that treats runoff from a several acre facility may cost a hundred thousand dollars or more. There are no quick fixes or easy solutions: a small inexpensive filter system (such as a simple catch basin fabric filter or placing absorbent booms around an inlet) is not going to result in a high level of treatment and may require frequent maintenance and replacement. Consider cleaning, replacement, and maintenance costs.

Maintenance Requirements

Maintenance activities and frequencies are product-specific and may vary based on the influent pollutant load; consult manufacturer guidance.

Frequency	Activity
Every 6 to 12 months	• Inspect for obvious signs of clogging or system failure. • Remove sediment and floatables (check state guidelines for disposal). • More frequent inspection may be warranted in first two years.
Every 1 to 2 years	• Replace media (full or partial replacement)
Personnel and operations	• Maintenance tasks may require specialized training, personnel, and/or equipment. • Confined space entry regulations should be followed if applicable • Vacuum trucks may be used to maintain underground devices.

References

StormFilter®, Vortech®, StormCeptor®: http://www.contech-cpi.com/Products/Stormwater-Management.aspx

StormwateRx: http://www.stormwaterx.com

Up-Flo Filter: http://www.hydro-international.biz

Flo-Gard® Catch Basin Filter, http://www.kristar.com

Ultra-Urban® Catch basin Filter, http://www.abtechindustries.com

Triton® Catch Basin Insert, http://www.conteches.com

WaterTectonics®, http://www.WaterTectonics.com

Using WinSLAMM to Predict the Performance of Treatment Technologies

The water quality model WinSLAMM (Source Loading and Management Model for Windows) can be used to predict pollutant removal and optimize the design and application of various stormwater treatment systems. WinSLAMM has been used to examine the performance of biofilters, grassed swales, and wet ponds in a “typical” scrap recycling facility. Biofilters and grassed swales would reduce runoff volume and particulate pollutants through infiltration, filtration by the soil and vegetation, and sedimentation as particulates settle. Wet ponds would not reduce runoff volume but would remove particulate pollutants. Because soils in scrap facilities tend to be highly compacted, it was assumed that infiltration would be limited. None of these treatment systems would be very effective at removing filterable metals or very small particles.

<u>Biofilters</u>

Biofilters that covered 10% of the facility area would reduce total suspended solids loadings by about half, and would have about a 10-year service life before clogging. The metals copper, lead, and chromium would also be reduced by about 50%, while zinc reductions would only reach 11% because zinc is predominantly filterable. Further reductions in metals could be achieved by placing special filter media (peat) in the biofilter.

<u>Grassed Swales</u>

WinSLAMM shows that the pollutant removal benefits of grassed swales are almost entirely due to reduced runoff volumes. Because of the compacted soils at scrap facilities, swales were not found to provide effective treatment. Percent reductions in all pollutants were 10% or less.

<u>Wet Ponds</u>

Wet ponds, the most commonly used stormwater treatment system used by scrap recyclers, can effectively reduce peak flows and pollutant loadings. A pond sized at 3% of the facility area would remove about 80% of the total suspended solids and particulate metals. A pond sized at 6% would remove 90% of the pollutants. At 3% of the drainage area, about one foot of sediment would accumulate in the pond after a 30 year period.

WinSLAMM can also be used to evaluate the performance of various combinations of treatment systems (such as biofilters + a wet pond). WinSLAMM was used to identify advanced treatment controls that would target filterable and small particulate metals – which are the most difficult to treat. The model demonstrated that the following treatment systems, if properly sized and designed, could be extremely effective at removing filterable and small particulate metals:

- Chemical treatment

Chemical treatment is commonly used in water treatment applications. Coagulants such as alum (aluminum sulfate), ferric chloride, or organic polymers are added to the water, followed by amalgamation (mixing) which form flocs which quickly settle. The addition of chemicals to treat stormwater and the disposal of settled and accumulated flocs are subject to state guidelines. Ferric chloride was found to be particularly effective, with predicted removals being over 90% for turbidity, 98% for lead, 90% for copper, and lower reductions for zinc. Alum treatment was found to be less effective (about 80 – 85% removals), and there were also concerns about potential toxicity caused by filterable aluminum. Final effluent levels were estimated to be as follows:

  - Turbidity < 10 NTU
  - Copper <50 µg/L
  - Lead < 10 µg/L
  - Zinc < 150 µg/L

- Lamella Plates to Enhance Sedimentation

  Lamella plates are used in underground tanks to improve sedimentation by increasing the effective surface area of the tank. While improved pollutant reductions were shown, it was concluded that enhanced tanks would best be used as pre-treatment devices, followed by chemical treatment or filtration in order to achieve a high level of treatment.

- Enhanced Media in Biofilters

  The metal removal efficiency of biofilters can be substantially improved by incorporating mixtures of rhyolite sand, zeolite, granular activated carbon, and peat. Pre-treatment is needed to prevent the biofilters from clogging. The biofilters performed best when they had slow to moderate flow rates and water/media contact times of at least 10 to 40 minutes. Contact times of less than 10 minutes were ineffective for metal removal. The best media mixture was found to be 30% rhyolite sand, 30% surface modified zeolite, 30% granular activated carbon, and 10% peat.

- Advanced Treatment Trains

  Treatment train performance can be improved by selecting media similar to that discussed above for biofilters. A properly designed treatment train can achieve the following effluent quality:

- Suspended solids <10 mg/L
- Copper <15 µg/L
- Lead <7 µg/L
- Zinc < 60 µg/L

<u>Conclusion</u>

WinSLAMM is a useful tool that can be used to estimate pollutant loadings and concentrations, quantify treatment system performance, and help design optimal treatment features and combinations.

As part of the Phase II ISRI Study, Drs. Shirley Clark from Pennsylvania State University Harrisburg and Robert Pitt from the University of Alabama designed and conducted a stormwater sampling study to evaluate the effectiveness of existing BMPs and treatment technologies at selected scrap recycling facilities across the United States and to develop an industry-calibrated version of WinSLAMM, a stormwater quality model that can provide estimates of treatment effectiveness.

The purpose of the sampling study was to provide a credible database that would help determine the effectiveness of various stormwater controls, and to identify and characterize any design, construction, and maintenance features that may limit the pollutant removal performance of the treatment technologies.

The stormwater sampling study investigated the potential of three treatment technologies – sedimentation, filtration, and coagulation prior to sedimentation – to treat the runoff from scrap facilities prior to discharge to either surface waters or to a municipal storm sewer system. In the sedimentation category, three configurations of devices were investigated: proprietary high-flow hydrodynamic separators, baffled sedimentation devices, and dry detention ponds. One of the detention ponds was an infiltrating pond where the runoff during low flow events infiltrated into the soil prior to reaching the pond discharge location. The filtration systems investigated included an upflow sand filter and a filter series using carbon and zeolite as the treatment media. One coagulation-sedimentation system was investigated, which used a proprietary coagulant and flocculant to enhance sedimentation of particulate matter in the runoff.

The primary potential pollutants of concern were suspended sediment, metals, and chemical oxygen demand (measured as a surrogate for organic pollution). Influent and effluent samples were collected from a minimum of 10 storm events for each treatment system, except the mixed media filtration system (eight events) and the coagulation-sedimentation system (three events). A particle size distribution was performed on some samples to determine the metals associated with various particle sizes and to evaluate the potential for treatment. In addition to comparing influent versus effluent water quality for the storm events, the effluent quality was compared against the California Numeric Action Levels (NALs) and the 2015 Federal MSGP benchmarks. The potential for groundwater impacts at the infiltrating dry pond was reviewed by collecting and analyzing core samples in the pond and modeling the pollutant migration potential.

The stormwater sampling data collection was conducted in 2013-2015 at six scrap metal recycling facilities located at various locations within the United States. Each facility was inspected, and a stormwater sampling program using automatic sampling equipment was designed and installed by experienced sampling contractors. During the period of study, the automatic samplers were maintained by the contractors.

Sedimentation Treatment Systems

Sedimentation was effective for removing particles from the runoff, as expected. The hydrodynamic separators had mixed results, with one separator showing effective removal, although a second separator did not effectively reduce pollutant concentrations. The proprietary baffled sedimentation system (basically an oil/water separator) was effective at removing suspended sediment and certain metals. However, effluent quality may be reduced if flow rates are sufficiently high to resuspend captured sediment.

The two sedimentation tanks which operated as recirculation tanks did not effectively remove pollutants. The pumping of water to be used for dust suppression and to the final treatment stage for these recirculation/sedimentation tanks may have resuspended the captured sediment. Additionally, when these tanks were pumped down for on-site use of the water, they were often pumped almost empty which exposed the accumulated sediment to resuspension during subsequent storm events.

The two detention ponds were effective at reducing concentrations of suspended sediment and total metals. While both ponds performed well, the pond (Pond 1) that had a higher ratio of pond area to drainage area achieved better pollutant removal than the other pond (Pond 2).

Filtration Treatment Systems

Neither the mixed media filtration nor the upflow sand filter systems were effective at reducing pollutant concentrations. Both filtration systems had pre-treatment devices, which may have removed sediment loadings that otherwise would have been captured by the filters.

The upflow sand filter bed may have been fluidized since the design did not hold the sand in place. A fluidized bed will result in bed expansion and an increase in the pore size in the media. The increase in pore size will result in decreased capture of small particles. The sand media was replaced halfway through the sampling period, which somewhat improved performance.

The carbon-zeolite filter media contained larger pore sizes because the media particles themselves are large. Successful filtration requires a successful interaction between the media and the pollutant. When the pore size is larger, the flow-through rate can be larger, reducing the contact time between the water and the media. Reductions in contact time can result in reduced pollutant removals. In addition, the influent water had low pollutant concentrations, so further removal may have been difficult.

Coagulation-Sedimentation Treatment System

The coagulation-sedimentation system injected a coagulant and flocculant into the flow as the pumped water moves from the sedimentation pre-treatment to the clarifier. The chemicals caused the smaller particles to clump together into larger particles that more easily removed. This system resulted in excellent removal of most pollutants, especially total metals, many of which had effluent concentrations at or near the detection limit of the analytical method.

Treatment Train Treatment Systems

Three treatment trains were evaluated. All trains had sedimentation as the first stage. One train had an infiltrating dry pond as the polishing stage, a second train had carbon-zeolite media filtration, and the third train had coagulation-sedimentation as the final stage. The treatment trains evaluated were highly effective at removing pollutants. Even if one or more stages of the train have limited success in removing pollutants, the combination resulted in significant removals.

Comparison to CA Numeric Action Levels (NALs) and Federal Benchmarks

Consistently meeting the California NALs and Federal benchmarks will be difficult with the treatment technology evaluated in this study. The only treatment systems capable of meeting the Federal benchmarks for all metals were the coagulation – sedimentation system, and the treatment train consisting of pre-treatment sedimentation and coagulation-sedimentation. However, the treatment train system did not meet the benchmark for chemical oxygen demand. Other treatment technologies tested, even if achieving significant pollutant removal, were unable to meet all of the benchmarks and NALs.

The treatment train with pretreatment sedimentation and carbon-zeolite filtration was able to meet the Federal benchmark for most storms for most pollutants. This system likely could be improved by slowing the flow rate of the system, allowing for greater contact time. In many urban stormwater filtration systems, sand has been added to the media to slow the flow through the media and increase the contact time. In addition, the media selection can be optimized for metals. Media that have had success for metals include some composts, peat moss, and zeolite. Additions of small amounts of one of these media may provide an improvement in the treatability of metals in the system. However, any media selected must be evaluated for whether or not it will leach one or more pollutants, defeating its selection as a treatment medium. The treatment train with the infiltrating dry pond, though achieving high pollutant removal, was unable to meet the benchmarks for copper, iron, and zinc.

This conclusion is consistent with findings of a study of stormwater treatment by Timothy Simpson, PE GE, Vice President of GSI Environmental. In a September 12, 2016 presentation at the CASQA Convention in San Diego, CA, Simpson reported that the treatment systems evaluated were often unable to meet the NALs for metals and COD. In particular, less than half of the treated samples met the NAL for copper.

Maintenance of Stormwater Treatment Systems

Maintenance is an important requirement for all types of treatment technologies. Accumulated sediment must be periodically removed from tanks, ponds, and other storage devices to prevent scouring and resuspension of sediments. Proprietary devices generally designate a pre-determined level of acceptable sediment accumulation to avoid these problems.

Filtration media replacement is important to maintain performance, as seen in the upflow sand filter. The media was replaced between storms 7 and 8 and metal removal substantially improved.

Groundwater Impacts from Infiltration

There exists a potential for impacts due to stormwater infiltration at some scrap recycling facilities, even after pretreatment by a proprietary sedimentation device. The risk would be especially problematic if the soils were sandy and the groundwater table was high. Zinc is likely to be the most mobile metal because it is most likely to be filterable and has a lower partitioning coefficient with the soil. One evaluation of a treatment system on a loam soil underlain by sand found that vertical migrations of more than one meter can be expected within a couple of decades if not sooner. Lesser migrations will be expected if the soil has a higher organic matter content at the lower layers and if the infiltration rate is smaller. The slower infiltration rate results in increased contact time with the soil and the organic matter in the soil typically is very effective at binding metals and organics.

Effectiveness of Best Management Practices

Although the primary focus of the stormwater sampling study was to determine the effectiveness of stormwater treatment technologies, there were some indications on the effectiveness of BMPs or operational source controls. There is no question that BMPs help prevent pollution and reduce the exposure of contaminants to storm runoff. Good BMP implementation is an important part of any professional recycling operation. However, the analysis of the influent samples (prior to treatment) generally indicates that BMPs alone are unlikely to be able to consistently meet the Federal benchmarks.

Section Nine Selection of Stormwater Treatment

The evaluation of stormwater treatment options and selection of a treatment system will likely require the assistance of a professional consultant or engineer, although some of the treatment system manufacturers are well qualified and will be helpful.

Selection Criteria

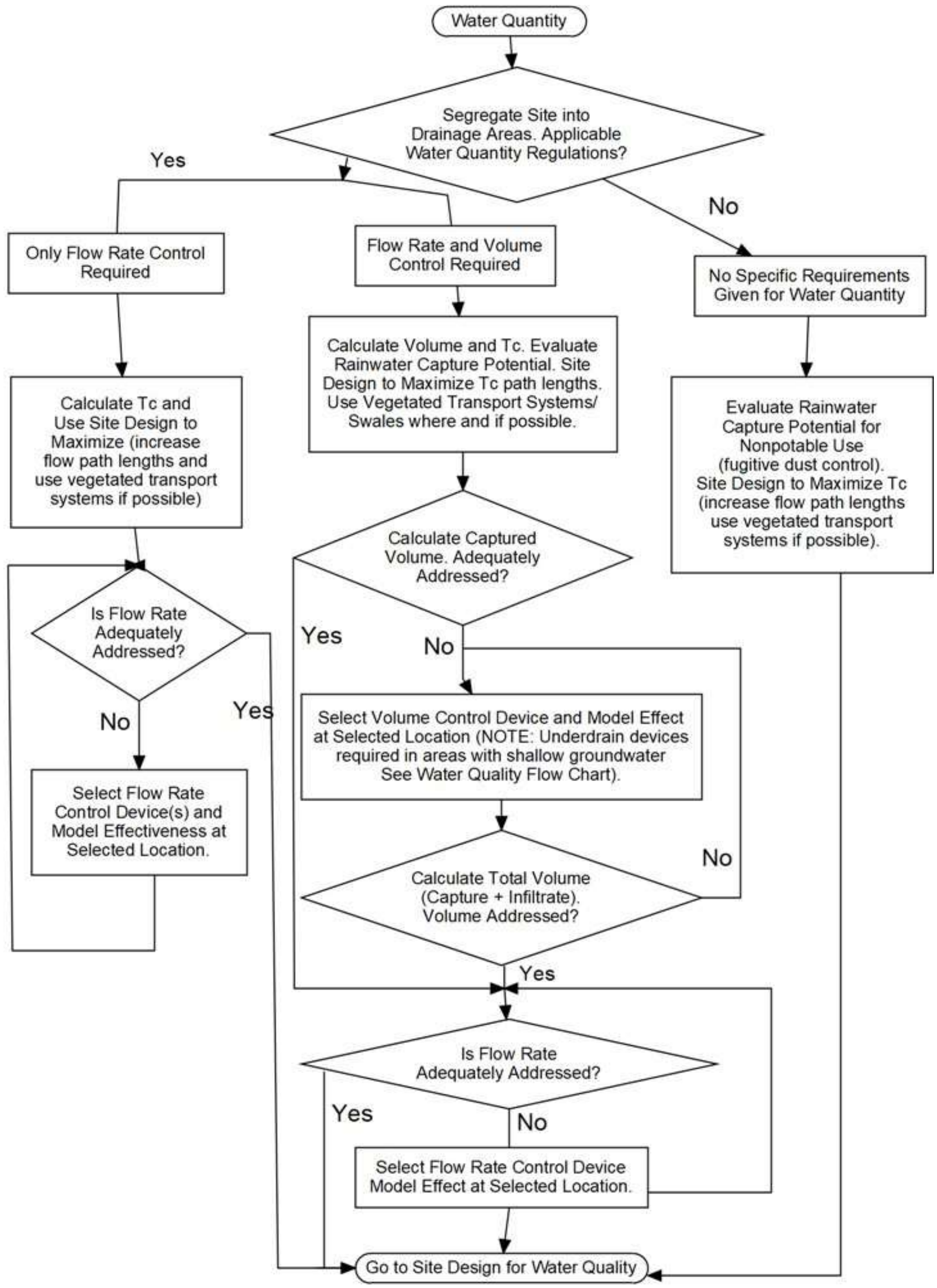
1. Water Quality & Quantity
   - Sampling results; TMDL requirements
   - % pollutant removal needed
   - Effluent concentration needed
   - Peak flow or volume control
   - BMP assessment
2. Site Constraints
   - Space requirement
   - Drainage area
   - Surface or subsurface
   - Excavation depth
   - Soils/groundwater
3. Owner Considerations
   - Capital cost
   - Maintenance
   - Regulatory acceptance

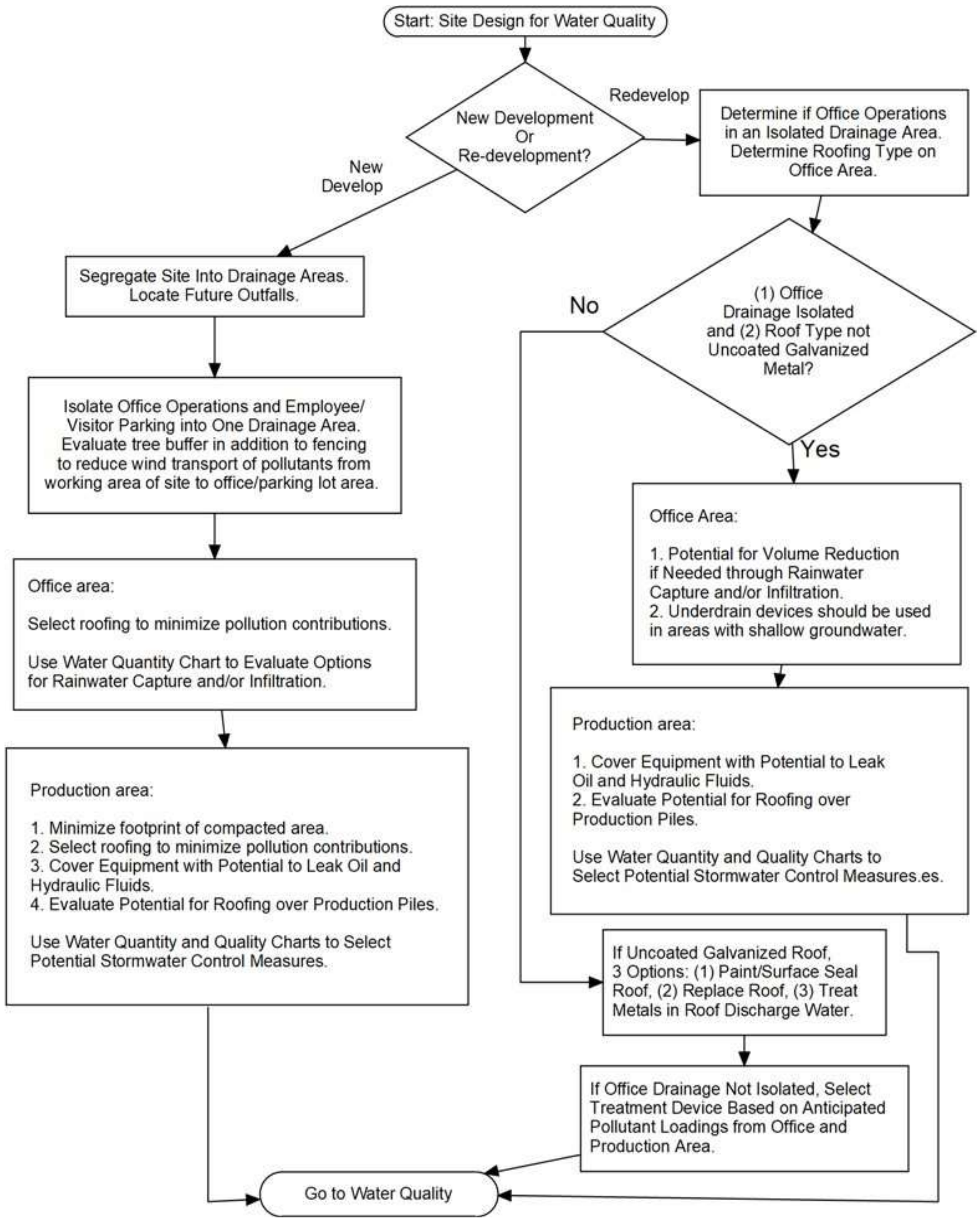
The attached decision flow charts can help guide recyclers through the process:

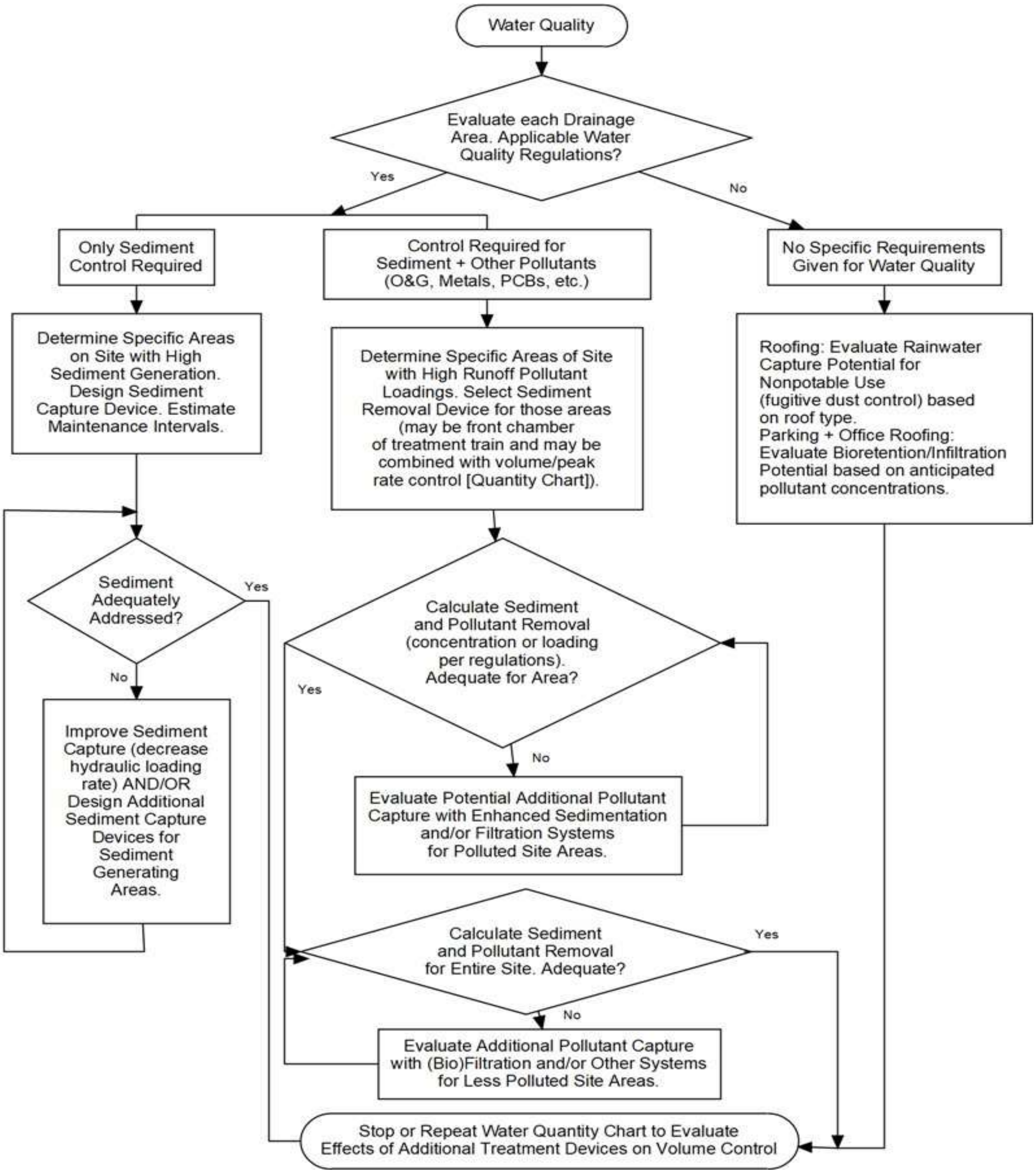
- **Facility Design Decision Flow Chart:** Stormwater treatment often accompanies expansion or modification of the recycling operation (new buildings, additional pavement, stormwater drainage changes). The chart offers examples on how segregating "clean water" from industrial runoff, and modifying building and pavement plans can reduce the volume of water that may require treatment.
- **Water Quantity Decision Flow Chart:** In addition to water quality control, flow rate and/or flow volume controls may also be needed. Correctly integrated, flow quantity controls (providing detention and slowing conveyance) often help provide water quality benefits as pollutants settle and are filtered by vegetation. Conversely, drainage problems – such as a frequently flooded roadway or scrap storage area – are often accompanied by water quality problems such as scouring and erosion. If water quantity

is not a concern, treatment systems such as filtration and chemical treatment become more viable.

- **Water Quality Decision Flow Chart:** Identify which pollutants need significant reduction, define the sources of those pollutants, and estimate loadings and concentrations (WinSLAMM will be helpful). Many recyclers, especially those with large facilities, will first consider passive treatment such a wet ponds or biofilters, which may be preferable if land is available and soil and groundwater conditions are suitable. Media filtration, modified vaults, MCTT, and proprietary systems can be evaluated, sized, and located to address smaller specific source areas. Study the treatment options listed in this report, consider the pollutant removal effectiveness that can be expected, and discuss options with consultants and manufacturers.


Water Quantity
Segregate Site into Drainage Areas. Applicable Water Quantity Regulations?
Yes
No
Only Flow Rate Control Required
Flow Rate and Volume Control Required
No Specific Requirements Given for Water Quantity
Calculate Tc and Use Site Design to Maximize (increase flow path lengths and use vegetated transport systems if possible)
Calculate Volume and Tc. Evaluate Rainwater Capture Potential. Site Design to Maximize Tc path lengths. Use Vegetated Transport Systems/ Swales where and if possible.
Evaluate Rainwater Capture Potential for Nonpotable Use (fugitive dust control). Site Design to Maximize Tc (increase flow path lengths use vegetated transport systems if possible).
Calculate Captured Volume. Adequately Addressed?
Is Flow Rate Adequately Addressed?
Yes
No
Yes
No
Select Volume Control Device and Model Effect at Selected Location (NOTE: Underdrain devices required in areas with shallow groundwater See Water Quality Flow Chart).
Select Flow Rate Control Device(s) and Model Effectiveness at Selected Location.
Calculate Total Volume (Capture + Infiltrate). Volume Addressed?
No
Yes
Is Flow Rate Adequately Addressed?
Yes
No
Select Flow Rate Control Device Model Effect at Selected Location.
Go to Site Design for Water Quality


Start: Site Design for Water Quality
New Development
Or
Re-development?
Redevelop
New
Develop
Determine if Office Operations in an Isolated Drainage Area. Determine Roofing Type on Office Area.
Segregate Site Into Drainage Areas. Locate Future Outfalls.
No
(1) Office Drainage Isolated and (2) Roof Type not Uncoated Galvanized Metal?
Yes
Isolate Office Operations and Employee/ Visitor Parking into One Drainage Area. Evaluate tree buffer in addition to fencing to reduce wind transport of pollutants from working area of site to office/parking lot area.
Office Area:
1. Potential for Volume Reduction if Needed through Rainwater Capture and/or Infiltration.
2. Underdrain devices should be used in areas with shallow groundwater.
Office area:
Select roofing to minimize pollution contributions.
Use Water Quantity Chart to Evaluate Options for Rainwater Capture and/or Infiltration.
Production area:
1. Cover Equipment with Potential to Leak Oil and Hydraulic Fluids.
2. Evaluate Potential for Roofing over Production Piles.
Use Water Quantity and Quality Charts to Select Potential Stormwater Control Measures.es.
Production area:
1. Minimize footprint of compacted area.
2. Select roofing to minimize pollution contributions.
3. Cover Equipment with Potential to Leak Oil and Hydraulic Fluids.
4. Evaluate Potential for Roofing over Production Piles.
Use Water Quantity and Quality Charts to Select Potential Stormwater Control Measures.
If Uncoated Galvanized Roof, 3 Options: (1) Paint/Surface Seal Roof, (2) Replace Roof, (3) Treat Metals in Roof Discharge Water.
If Office Drainage Not Isolated, Select Treatment Device Based on Anticipated Pollutant Loadings from Office and Production Area.
Go to Water Quality


Water Quality
Evaluate each Drainage Area. Applicable Water Quality Regulations?
Yes
No
Only Sediment Control Required
Control Required for Sediment + Other Pollutants (O&G, Metals, PCBs, etc.)
No Specific Requirements Given for Water Quality
Determine Specific Areas on Site with High Sediment Generation. Design Sediment Capture Device. Estimate Maintenance Intervals.
Determine Specific Areas of Site with High Runoff Pollutant Loadings. Select Sediment Removal Device for those areas (may be front chamber of treatment train and may be combined with volume/peak rate control [Quantity Chart]).
Roofing: Evaluate Rainwater Capture Potential for Nonpotable Use (fugitive dust control) based on roof type.
Parking + Office Roofing: Evaluate Bioretention/Infiltration Potential based on anticipated pollutant concentrations.
Sediment Adequately Addressed?
Yes
No
Improve Sediment Capture (decrease hydraulic loading rate) AND/OR Design Additional Sediment Capture Devices for Sediment Generating Areas.
Calculate Sediment and Pollutant Removal (concentration or loading per regulations). Adequate for Area?
Yes
No
Evaluate Potential Additional Pollutant Capture with Enhanced Sedimentation and/or Filtration Systems for Polluted Site Areas.
Calculate Sediment and Pollutant Removal for Entire Site. Adequate?
Yes
No
Evaluate Additional Pollutant Capture with (Bio)Filtration and/or Other Systems for Less Polluted Site Areas.
Stop or Repeat Water Quantity Chart to Evaluate Effects of Additional Treatment Devices on Volume Control

- **Stormwater Characteristics**
  - Scrap metal recycling facilities are often large operations that have extensive metal scrap inventory and heavy equipment stored outside and exposed to stormwater runoff. Stormwater runoff from these facilities can contain relatively high levels of metals and sediment. The metals of greatest concern are iron, aluminum, copper, zinc, and lead. Most of these metals (except zinc, which is mostly filterable) are largely associated with small particles that are readily transported in runoff and difficult to control.

- **Stormwater Regulations**
  - Stormwater regulations are authorized by the Clean Water Act. Regulations are becoming more stringent as the Federal and State regulatory agencies strive to meet water quality standards in lakes and streams. The prevailing trends for stormwater permits, which are renewed every five years, are to require more stormwater sampling, visual observations, numeric benchmarks and limits, and mandatory actions that must be taken when those benchmarks and limits are exceeded. New requirements such as Total Maximum Daily Load (TMDL) limits will further complicate stormwater compliance. As these permits become more challenging, scrap recyclers are more likely to be subject to regulatory enforcement actions and third party lawsuits.

- **Facility Design and Engineering**
  - Consider paving roadways and other areas subject to erosion
  - Use buildings, containment and covers to reduce exposure to stormwater, especially for “hot spots”
  - Minimize the number of locations where stormwater is discharged from facility
  - Where possible, segregate “clean” runoff (from parking lots and landscaped areas) from industrial runoff. Clean water may be stored and reused.
  - In general, surface runoff (overland flow, swales and ditches) is preferable to subsurface conveyance (catch basins and sewers). However, subsurface conveyance may be required by local ordinance or needed for a stormwater treatment system

- **Best Management Practices**
  - BMPs are the most important part of a stormwater pollution prevention plan
  - BMPs prevent pollution and exposure to stormwater runoff
  - BMPs should address inbound scrap, spill control, equipment maintenance, scrap processing, scrap management, pavement sweeping, fluid storage, erosion control, employee training, non-stormwater discharges, and natural waterways and wetlands adjacent to facility
  - Good BMPs will promote stormwater compliance and reduce the need for treatment
  - For many scrap recycling facilities, the best strategy is to prevent stormwater exposure of "hot spot" problem areas, implement excellent BMPs, and try to avoid the need for stormwater treatment

- **Stormwater Treatment**
  - Will supplement BMPs and help meet numeric benchmarks and limits
  - Most treatment systems need a pretreatment device to remove larger sediment particles that can clog the treatment system and reduce performance
  - The preferred treatment systems for scrap recyclers use stormwater detention (storage), filtration through a filter media, or chemical treatment (coagulation and flocculation)
  - Treatment trains involve a series of treatment systems to improve pollutant removal. Typically, sedimentation is followed by filtration or chemical treatment
  - Sedimentation treatment systems include ponds, constructed wetlands, oil/water separators, hydrodynamic devices, catch basins, and sediment tanks
  - Filtration treatment systems include sand filters, multi-media filters, and biofilters
  - The preferred composition of filter media for scrap recyclers may include rhyolite sand, peat, granular activated carbon (charcoal), and zeolite
  - Several proprietary treatment systems have been used at scrap recycling facilities. Commercial filtration systems have their own proprietary filter media.

- **Stormwater Treatment Limitations**
  - Stormwater treatment can be expensive and complicated
  - Stormwater treatment systems should be professionally sized, designed, and installed
  - Most treatment systems require periodic maintenance, including removal of accumulated sediments

- Stormwater treatment systems have uncertain pollutant removal performance. Stormwater treatment systems may not be able to achieve high pollutant reductions where the influent concentrations are already low. There is also a potential for scour or washout of previously trapped pollutants. Several of the treatment systems at scrap recycling facilities evaluated as part of the ISRI Stormwater Sampling Study did not perform as well as expected. Most treatment systems were not able to consistently meet the federal benchmarks.
- If treated water infiltrates the soil, the risk of groundwater impacts should be evaluated, particularly in areas with sandy soils or high groundwater levels.

- **Industry-Specific WinSLAMM Model**
  - A recycling industry-specific version of WinSLAMM Version 10 was produced for ISRI as part of ISRI's Stormwater Study. WinSLAMM Version 10 models stormwater treatment systems using hydrologic and hydraulic routing and pollutant treatability for different treatment technologies. Use of the Study data to calibrate WinSLAMM improves its ability to predict stormwater treatability for pollutants found in scrap metal recycling runoff. A User's Guide to ISRI's version of WinSLAMM is available to provide guidance to facility owners and their consultants who are using the model to determine the appropriate number and type of stormwater controls for their facilities.