A manual developed by members of the California Construction & Industrial Materials Association (CalCIMA) in conjunction with the State Water Resources Control Board.
READY MIXED CONCRETE
PROCESS WATER
BEST MANAGEMENT PRACTICES MANUAL

CalCIMA

August XX, 2012

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August 18, 2012

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1.0 INTRODUCTION

1.1 Scope and Purpose

Ready mix concrete batch facilities manufacture Portland cement concrete, a fundamental component of virtually every public- and private-sector construction project.

The manufacturing processes and supporting operational activities (collectively referred to as “operational activities”) have the potential, if not properly managed, to affect surface water and ground water. This manual of Best Management Practices has been designed to provide guidance to the ready mix concrete industry in the State of California to mitigate that potential, thereby protecting the waters of the State from negative impacts to surface water and ground water from these operational activities.

This manual has been prepared by a consortium of producers operating in the State of California, with the cooperation of the State’s lead water quality regulatory agency, the State Water Resources Control Board (SWRCB). The State’s producers have been assisted in this effort by two of their industry groups, the California Construction and Industrial Materials Association (CalCIMA) and the National Ready Mix Concrete Association (NRMCA).

1.2 History

Because the ready mix industry uses ground areas for temporary placement of process water and returned concrete, it is subject to the provisions of the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) – an act designed to protect surface water and ground water in the State. These activities at ready mix facilities have not historically had significant regulatory oversight, other than under a general industrial stormwater discharge permit (with occasional exception for ready mix facilities co-located with other facilities regulated by a Waste Discharge Requirements order).

Under the Porter-Cologne Act provisions, the State has the authority to issue a Waste Discharge Requirements order to each individual ready mix facility. Need statement regarding the role this BMP manual may play in future regulatory compliance.

In response to a prior effort to draft a regional general Waste Discharge Requirements order for the Central Valley Region, the industry funded original research that recognized that a properly designed and managed program of BMPs can effectively mitigate threats to water quality.

The results of that work are included by reference where appropriate and as an appendix to this document.

A more detailed timeline of that prior regulatory effort is presented in the Appendices.
1.3 Overview

In the subsequent sections, this manual describes:

- **Operational Processes.** Ready mix concrete batch facilities manufacture ready mix concrete. The designs of these facilities vary widely and no two are identical, however the processes used in manufacturing are similar from facility to facility. The purpose of this section is to provide an overview of operational processes, so that the potential for impacts to surface water and/or ground water can be better understood. This section is not prescriptive; it is descriptive; i.e., this is not a manual of operational practice. Additionally, the operational processes described do not apply to all facilities.

- **Potential Water Pollutants.** The potential pollutants or threats to water quality are generally process-specific, i.e., certain facility processes are more likely to generate a particular potential pollutant than are other facility processes. The potential pollutants are described in general, and then by relationship to process and, where applicable, by relationship to the facility feature or manufacturing component.

- **Best Water Management Practices.** These are practices which, when properly designed and implemented, can mitigate the potential for negative impacts to surface water and/or ground water. These water management practices can be generally divided into three groups: 1) practices which involve the design of the facility, 2) practices which involve improvements to existing facility design, and 3) management practices which modify facility operations.
2.0 OPERATIONAL OVERVIEW

2.1 Ready Mix Concrete

All ready mix concrete batch facilities produce ready mix concrete, often referred to as Portland-cement concrete (so-called because Portland cement has historically been the primary cementitious material). Conceptually, the batching of ready mix concrete consists of the combining and mixing of prescribed amounts of cementitious material, aggregates (rock and/or sand), water, and possible admixtures.

- The cementitious materials used include Portland cement, flyash, and slag.
- The aggregates used include naturally occurring screened, washed, and sometimes crushed rock and/or sand.
- The water used is typically sourced from municipal supply or groundwater well. Process water generated during operational activities can be reintroduced to batch processes, as further described in subsequent sections.
- Admixtures used in the manufacture of ready mix concrete are widely variable and are described more fully later in this manual.

2.1.1 Central Mix Facilities vs. Transit Mix Facilities

A significant operational feature that divides ready mix facilities into two classes is the type of mixing employed. In a Central Mix facility, the concrete is mixed in plant-mounted equipment prior to being dispensed into a waiting ready-mix-concrete delivery truck (a.k.a.: ready mix truck). In a Transit Mix facility, the unmixed concrete components are placed directly into the ready mix truck and are mixed by the rotating drum of the truck on the way to the jobsite.

2.1.2 Ready Mix Concrete Batch Process Overview

A brief overview of the ready mix concrete batching process will facilitate an understanding of plant processes... additional detail of batch processes will be presented in other areas of this manual.

- The Batch Process Concept
  - Batches of ready mix concrete are manufactured by weight – the weight of each individual raw material.
  - Some of each raw material (aggregates, cementitious materials, water, admixtures) must be “at-the-ready” to be introduced into its respective weighing process.

- The Batch Plant
  - The weighing and combining of the raw materials takes place in the batch plant.
  - The batch plant consists of:
    - Sufficient inventories of raw materials to manufacture at least one batch of ready mix concrete,
    - Weighing vessels,
    - The equipment necessary to move those raw materials into weighing vessels, and
    - The equipment necessary for moving the raw materials into and through the plant mixer (if the facility is a Central Mix facility) and into the ready mix truck.
• The Mix Design
  o The mix design is a “recipe” for the manufacture of a specific batch of ready mix concrete.
  o The mix design includes the weights of each raw material component required to produce the batch.

• Raw Material Inventory
  o As stated above, sufficient inventory of each raw material must be “at-the-ready” in the batch plant to be introduced into the batch process.
  o In many facilities, the capacity of “at-the-ready” inventory in the batch plant is insufficient to maintain extended production of ready mix concrete batches.
  o In most facilities, additional inventories of raw materials are maintained to feed the batch plant process.

• The Batch Process – In the Batch Plant
  o A customer requests a batch of ready mix concrete, to be manufactured according to a predetermined mix design.
  o The mix design drives a batch computer, which in turn drives various automated, sequential or simultaneous plant processes:
    ▪ One or more aggregate materials will be dispensed into one or more weigh hoppers.
    ▪ One or more cementitious materials will be dispensed into other weigh hopper(s).
    ▪ Water will be weighed or metered.
    ▪ Admixtures, if called for, will be similarly weighed or metered.
  o These raw materials will be combined, using conveyors, mechanical gates & valves, and other mechanisms, into:
    ▪ The plant mixer drum (for a Central Mix facility), or
    ▪ A waiting ready mix truck (for a Transit Mix facility).

• Delivery of Ready Mix Concrete
  o The mixed concrete is delivered to the customer.
  o Excess material not utilized by the customer typically returns to the facility – where it is resold or reused or reclaimed or disposed as described later.
  o The ready mix truck rinses the inside of the drum in preparation for the next batch of concrete to be delivered.

• Repeat
  o The process repeats, up to several hundred times per day.

• Time-Sensitive Nature of the Process
  o Fresh ready mix concrete is frequently described as “uncured” – meaning it is workable.
  o Most applicable standards require that uncured ready mix concrete be placed into its final disposition within 90 minutes of the time of manufacture.
2.2 Aggregates
The methods for handling aggregates at ready mix facilities vary widely. Aggregate sources and transportation, and methods for receiving, handling, and storage are presented below.

2.2.1 Aggregate Types
Aggregates used in the manufacture of ready mix concrete are usually coarse and fine aggregates that are generally described as follows:

- **Coarse Aggregates.** Coarse aggregates are generally defined as rock or gravel approximately one-quarter inch or larger. The aggregates are generally washed at the source (quarry, mine, etc.) and require little additional water at the plant except in the hottest regions, where water may be added (sprinklers) for moisture content and temperature management.

- **Fine Aggregates.** Fine aggregates are generally defined as rock or gravel particles less than one-quarter inch, a.k.a. “sand.” Because of surface area, fine aggregates are typically received with higher water contents (by weight) than coarse aggregates. Additionally, fine aggregates may be sprinkled, either in stockpiles or while on conveyors during the handling process, for management of dust, and for production of quality ready mix concrete.

- **Non-Standard or Specialty Materials.** Most producers handle non-standard or specialty materials from time to time. These include screened glass particles, oyster shells, natural or manufactured low density aggregates (a.k.a. “lightweight” aggregates), and various products that are incorporated for architectural purposes.

2.2.2 Aggregate Transportation
The washed and graded aggregates are delivered to the ready mix facility using a variety of transportation modes:

- **Over-the-Road Trucking.** Over-the-road trucks deliver aggregates to the ready mix facility in bottom-dump trucks and end-dump trucks.

- **Rail.** Some ready mix facilities are equipped with rail spurs, in which case bottom-unloading rail cars may be used to deliver aggregates.

- **Barge/Ship.** Some ready mix facilities with frontage on navigable waterways receive aggregates by barge or ship. Unloading from the barge or ship typically utilizes buckets and/or conveyors that transfer the aggregates from barge or ship to shore.

- **Quarry-Fed Facilities.** Some ready mix facilities are co-located with a mine or quarry that produces aggregates. In these facilities, aggregates are transported to the ready mix facility using conveyors, over-the-road trucks, or off-road mine trucks (a.k.a. “ukes”).

2.2.3 Aggregate Receiving
The methods used for receiving aggregates at ready mix facilities vary widely, but several practices dominate:

- **Drive-Over Hopper.** Many ready mix facilities are equipped with a drive-over hopper, also referred to as a grizzly. An aggregate delivery vehicle (bottom-dump truck, end-dump truck, or uke) dumps the aggregate through the grizzly bar structure into the hopper. The hopper is
fitted, at its base, with a clamshell gate. The aggregates pass through the gate onto a moving conveyor belt beneath the gate.

- **Windrowing and Loader Receiving.** Aggregates received by truck are, in some instances, placed directly on the ground. The aggregates may be dumped into a pile, if delivered by an end-dump truck. If delivered by a bottom-dump truck, a ribbon of aggregate is laid on the ground. A front-end loader then moves the aggregates, into some form of ground storage, into a hopper for conveyor-feed of a stockpile or overhead bin, or directly into an overhead bin.

- **Conveyor Receiving.** Facilities that are co-located with an aggregate mine or quarry and facilities that are equipped to receive materials by ship or barge often receive the materials by conveyor. The conveyor may place the material into some form of ground storage, into intermediate overhead storage, or into the overhead plant storage.

### 2.2.4 Aggregate Storage

**Batch Plant Aggregate Inventory.** A primary objective of aggregate receiving, handling, and storage at the ready mix facility is to maintain the quality and separation of the aggregates, so that they can be “at-the-ready” for individual weighing in the batch plant for the manufacture of ready mix concrete. In most batch plants, the aggregates that are “at the ready” for introduction into the weighing process are located in bins or silos above the weigh hoppers.

**Additional Aggregate Inventory.** A second, but equally important objective of aggregate receiving, handling, and storage at the facility is to maintain sufficient inventories of materials within the facility, to maintain or replenish the supply of “at-the-ready” aggregates in the batch plant. Ready mix concrete facilities maintain these additional aggregate inventories in any of several configurations:

- **Above-Ground Storage Bins.** Some ready mix facilities maintain inventories of aggregates in above-ground storage bins. These bins may be constructed of steel or concrete; a few, older facilities may exist that are constructed of wood. Aggregates are typically introduced to these bins by conveyor. Aggregates are typically removed from these bins by conveyor as well.

- **Ground Storage Bunkers or Stockpiles.** Some ready mix facilities maintain inventories of aggregates using ground storage. Ground storage may take the form of an unconfined stockpile, or it may be confined on two or three sides by a confining structure, such as a wall of concrete or a wall of large concrete blocks. Aggregates may be added to the stockpile or bunker by conveyor or by loader or by direct dump. Aggregates may be removed from the bunker or stockpile by loader or by an underground tunnel fitted with gates and conveyor(s).

### 2.2.5 Aggregate Handling

To move the aggregates from the point or place at which they are received to their final disposition in the batch plant, several practices are used, but two dominate.

- **Conveyors.** Conveyors are used in some part of the ready mix batch process at virtually every facility. Conveyors are often utilized to move aggregates from the point of receipt to ground storage bunkers, ground storage stock piles, or overhead storage bins or silos. Conveyors are also often used to move aggregates from overhead bins or silos to other overhead bins or silos. Conveyors located in tunnels beneath ground storage stockpiles can also be used to move...
aggregates from these stockpiles into overhead storage. Conveyors are also typically used to move aggregates from the aggregate weigh hopper(s) to the plant mixer or the ready mix truck. The number and arrangement of conveyors is highly plant-specific and variety of configurations is too great for discussion in this manual.

- **Loader-Fed.** Some ready mix facilities are designed so that overhead storage bins or conveyor-feed hoppers can be accessed (fed) by a front-end loader.

- **Bucket Conveyors.** Some ready mix facilities utilize bucket conveyors to move materials. While standard, belted conveyors require substantial run distances for every unit of elevation achieved, a bucket conveyor transports aggregates vertically, with little run distance required. Bucket conveyors consist of buckets, attached to a drive mechanism, such as a chain, that scoop aggregates from a hopper, lift them vertically, and dump them into an overhead storage bin or silo.

### 2.3 Cementitious Materials

Cementitious materials are the materials that react with water and aggregate to form extensive crystalline structures that give ready mix concrete its high compressive strength. Because of their reactive nature, cementitious materials must be kept dry and protected from the elements. The methods of handling cementitious materials at ready mix facilities are significantly less varied than the methods for handling aggregates. Virtually without exception, cementitious materials are managed in fully enclosed systems – for transportation, receiving, and handling.

#### 2.3.1 Cementitious Materials Types

The cementitious materials used in ready mix concrete production include the following:

- **Portland cement.** This is the most reactive component of Portland cement concrete (ready mix concrete). It is manufactured throughout the world using processes that are not relevant to this manual.

- **Flyash.** Flyash is a byproduct of coal-fired energy production. The use of flyash in ready mix concrete imparts significant benefits to the uncured and cured states of ready mix concrete.

- **Slag.** Some ready mix concrete is produced using ground granulated blast furnace slag, a byproduct of refining operations. It, too, has reactive properties and imparts significant benefit to uncured and cured ready mix concrete.

#### 2.3.2 Cementitious Materials Sources

The three cementitious material types cited above are typically sourced from terminals located throughout the State. At these terminals, the cementitious materials are typically stored in fully enclosed above-ground silos.

#### 2.3.3 Cementitious Materials Transportation

Cementitious materials are transported from the respective terminals to the ready mix facility by one of two methods:

- **Over-the-Road Trucking.** The majority of ready mix facilities receive cementitious materials via fully enclosed, air-tight trailers (a.k.a. “pneumatics” or “powder trucks”). While the type of
cementitious material may vary and the type of truck is the same—fully enclosed, usually aluminum-bodied trailers, with gasketed closures.

- **Rail.** While not a prevailing operational feature, some ready mix facilities are equipped with rail spurs; those facilities may receive cementitious materials by rail. In these cases, the rail cars function similarly to the fully enclosed, air-tight trailers discussed above.

### 2.3.4 Cementitious Materials Receiving, Handling, and Storage

Almost without exception, cementitious materials are stored at ready mix facilities in fully enclosed silos. A pneumatic material handling system is used to move the cementitious materials from the delivery vehicle to the storage silo. This pneumatic material handling system consists of truck-mounted and/or plant-mounted blowers, transfer hoses and pipes, and emissions control equipment. The blowers pressurize the delivery vehicle, forcing the cementitious material through the hoses and pipes into the enclosed storage silos. Potential dust emissions from this process are controlled using one of two methods:

- **Bin Vent.** This is a generic industry term for a unit that functions passively or actively to control dust emissions. Essentially a box fitted with cartridge or sock-type filters, the air, pressurized by the materials-handling process, passes through the filtration media, and is discharged to the atmosphere free of particulate matter. The captured cementitious particles fall passively back into the cementitious materials silo.

- **Central Dust Collector.** This unit is essentially a giant vacuum—creating negative gauge pressure at potential cementitious dust emissions points. The ducted air is routed through filtration media and discharged to the atmosphere particulate-free. The recovered particles are driven under air pressure back into a cementitious materials silo.

Several methods are used to move cementitious materials from the storage silos into the ready mix batch process. Prior to being combined with the other ready mix concrete constituents (aggregates, water, admixtures), the cementitious materials must be weighed. To accomplish this, the cementitious material typically 1) passes (passively, by gravity) through some type of gate or valve mechanism or 2) is metered into the weigh hopper using some type of progressive cavity device, such as a material screw conveyor.

### 2.4 Admixtures

“Admixtures” is a broad, generic term used to describe materials that are added to ready mix concrete to affect strength, workability, consistency, set time, color, curing characteristics, density, permeability, water requirement, and pumpability.

#### 2.4.1 Types of Admixtures

Four general types of admixtures are used in the manufacture of ready mix concrete.

- **Fibers.** Fibers are added to ready mix concrete to improve strength characteristics and control cracking. Fibers take many forms and may be steel, fiberglass, or various synthetic materials, such as plastics.

- **Mineral Admixtures.** Mineral admixtures usually are used to alter the density, strength, or permeability of ready mix concrete. Mineral admixtures also take many forms. Some of the
more common mineral admixtures include silica fume, various clay products (e.g., metakaolin), finely ground limestone products, and similar branded products.

- **Color.** Colored concrete is very popular in both commercial and residential applications. Most concrete colorants are iron oxide-containing pigments. These pigments are available in liquid and in dry forms.

- **Chemical Admixtures.** Hundreds of chemical admixtures exist under various branded names that are used to affect the existing properties of ready mix concrete or impart additional qualities to the finished product. These products are available in liquid and in dry forms.

### 2.4.2 Admixture Batching

Admixtures are added to ready mix concrete in several ways.

- **Plumbed Through the Plant.** Most ready mix facilities have at least some admixtures that are plumbed through the plant and feed directly into the batch process. The batching of these admixtures is typically automated – as part of the overall automated batch process. These installations typically include a number of tanks of bulk admixture products, a control and pump enclosure, and hoses leading either to the plant mixer (Central Mix facility) or to the loading hopper (Transit Mix facility). The inventory of admixture product is replenished periodically by bulk delivery.

- **Fibers.** Most fibers are added manually. Depending on the type of fiber, the amount being added, and the application, the fiber may be manually added directly to the ready mix truck, it may be manually introduced to the plant mixer, or it may be introduced earlier in the batch process, via a weigh hopper or a conveyor.

- **Color.** Color is introduced to the batch process by several methods. Some facilities have automated dispensing systems for liquid or dry color that introduce the colorant directly into the ready mix truck. At other facilities or with seldom-used colors, the colorant may be manually added to the ready mix truck. Colorants are rarely introduced to the batch process prior to a plant mixer because the residual color remaining in the plant mixer may be problematic.

- **Manually Added Admixtures.** Many admixtures, either because of their consistency or the infrequency of use, are simply added manually to the batch process. Again, the product may be manually added directly to the ready mix truck, it may be manually introduced to the plant mixer, or it may be introduced earlier in the batch process, via a weigh hopper or a conveyor.

### 2.4.3 Admixtures Storage

Bulk liquid admixtures are typically stored in above-ground tanks that feed the admixtures by hose through pumps into the batch process. These tanks may have secondary containment. Automated dry and liquid color systems are also typically stored in enclosed structures with weighing, metering, and/or pumping systems. Manually added admixtures are typically stored in site structures to protect from the elements.
2.5 Water

Water is a fundamental raw material for the manufacture of ready mix concrete (along with aggregates and cementitious materials). Water activates the cementitious material and becomes part of the crystalline structure that is developed within the ready mix concrete as the concrete cures.

2.5.1 Sources of Water

Water used in ready mix concrete facilities can be sourced from municipal supply, from groundwater wells, from collected stormwater, and from other plant processes (a.k.a. “process water”).

2.5.2 Plant Processes that Produce Process Water

Process water is defined as any water that has been chemically affected by any plant process. Plant processes that produce process water are primarily associated with various rinsing/washing activities.

- **Plant Mixer Washing.** The plant mixer (Central Mix facilities) needs to be rinsed from time to time. The process water generated during this rinsing is typically loaded into a ready mix truck or loader bucket for eventual disposition in a process-water basin or reclaimer.

- **Loadout Area Dust Control.** The area where the ready mix concrete raw materials (Transit Mix facility) are loaded into the ready mix trucks may use spray bars to suppress dust during loadout activities. This water is process water.

- **Loadout Area Washing.** The area where the ready mix concrete (Central Mix facility) or the ready mix concrete raw materials (Transit Mix facility) are loaded into the ready mix trucks needs to be rinsed from time to time. The water generated during these wash activities is process water.

- **Truck Rinsing.** Following loading, a ready mix truck may need to be rinsed in order to remove concrete or concrete components from exterior truck surfaces. The water generated during these rinse activities is process water.

- **Truck Water Tank Filling.** Ready mix truck water tanks hold water used for job-site load adjustment and/or job-site wash activities. Non-process water is typically used to fill these tanks. When these tanks are overfilled, the spilled water may constitute a process water or a potential non-stormwater discharge.

- **Truck Washout.** At the end of the business day, and frequently at intervals throughout the business day, ready mix trucks need to wash out their drums. The water generated during these truck washout activities is process water.

- **Truck Cleaning.** Drivers often wash their ready mix delivery trucks using a variety of products. Soaps are used for the removal of grime; acids are typically used for the removal of concrete or cementitious material film.

- **Moisture Management: Aggregate Storage & Handling.** Aggregates may be sprinkled with water during storage and/or handling for purposes of 1) maintaining appropriate water content, 2) dust control, or 3) cooling. Excessive use of this water or failure to capture and recycle it may produce a potential non-stormwater discharge.

- **Site Dust Suppression & Yard Maintenance.** At some facilities, water may be used to suppress dust on both drive and non-drive surfaces. Water may also be used to rinse various areas of the
plant. Depending on the type of water used and the location of use, the water may be process water or may produce a potential non-stormwater discharge.

2.5.3 Stormwater
Stormwater is considered non-process stormwater if: 1) it falls on areas of the facility where no process water is present, 2) it falls on areas of the facility where no cement or uncured concrete is present, and 3) it does not comingle with process water is considered non-process stormwater.

2.5.4 Stormwater as Process Water
Stormwater is considered process water if: 1) it falls on areas of the facility where process water is present, 2) it falls where on areas of the facility where cement or uncured concrete is present, or 3) it comingles with process water.

2.6 Returned Material Management
Virtually every ready mix concrete facility is challenged with the management of returned material – material that is not used by the customer for whatever reason. Several operational processes are used to manage this returned material.

2.6.1 Stabilization and Resale
State guidance currently allows for stabilization and resale of up to fifteen percent by weight of return concrete, with certain time and notification parameters in place. Stabilization of returned concrete is accomplished using carefully measured doses of retarding chemicals. These chemicals temporarily halt the curing process. The practice of stabilization and resale is not extensively employed, because customers are not generally accepting of the practice, and because of incompatibility among mix designs.

2.6.2 Beneficial Reuse Using Forms
Many ready mix concrete facilities build large concrete blocks or other precast structures with returned concrete using commercially available forms. The finished products can be used to create aggregate bin walls, retaining walls, traffic barrier rails, parking lot bumpers, or rip rap for erosion control.

2.6.3 Reclaimers
Reclaimers are complex equipment packages that segregate returned concrete into 1) screened or unscreened aggregates and 2) cementitious-material-containing process water. The aggregates and process water can then be reintroduced into facility processes. Reclaimers are expensive to purchase, expensive to install, expensive to operate, and occupy significant space. Despite these drawbacks, reclaimers are often a significant tool in the effective management of returned material.

2.6.4 Beneficial Reuse – Aggregate Base
Market demand for aggregate base made from crushed returned concrete is growing – creating one-for-one conservation of the mining and manufacture of virgin material. Many ready mix facilities windrow returned material onsite or offsite. Once the material is cured, it is broken up and stockpiled for later incorporation into aggregate base. Sediments removed from the process water basin may be incorporated into the broken-up material.
2.6.5 Disposal

If returned concrete cannot be utilized by any of the methods presented above, the material must be stockpiled onsite for off haul to disposal.

2.7 Facility and Truck Maintenance

Maintenance of the equipment-intensive aspects of the manufacture of ready mix concrete is a necessary part of facility operations. The two are described below.

2.7.1 Facility Maintenance

Ready mix concrete facilities require constant maintenance.

- **Lubrication.** Rollers, gears, bearings, gates, etc. require periodic lubrication and/or change of lubricating fluids. Highly viscous greases and various types of gearbox and hydraulic oils are found at most facilities.

- **Steel.** The highly abrasive nature of the aggregate materials used in the manufacture of ready mix concrete accelerates the wearing-out of many steel surfaces throughout the ready mix plant. Maintenance crews routinely work to remove areas of worn steel (by cutting or torching) and replace the worn areas with new steel (by bolting or welding).

- **Hoses, Conveyor Belts.** The various rubber or synthetic rubber-like materials throughout the ready mix concrete facility are constantly being replaced, due to damage and wear.

- **Process Water Basin Maintenance/Sediment Removal.** The process water basins collect aggregates, cementitious materials, and water from plant processes. These materials need to be removed on a regular basis to maintain basin capacity. These materials are typically allowed to drain prior to offhaul for disposal. The materials may be placed so as to drain back into the process water basins, or may be placed in the area where return material is windrowed for beneficial reuse.

2.7.2 Truck Maintenance/Loader Maintenance

Ready mix truck maintenance occurs, to some extent, at every ready mix concrete facility where vehicles are domiciled. Many facilities perform only minor maintenance onsite, sending the trucks to in-company or vendor facilities for larger maintenance concerns.

- **Fueling.** Most ready mix delivery vehicles run on diesel fuel. Fueling can occur through onsite facilities, offsite facilities, or vendor-supplied onsite services (a.k.a. “wet hosing”).

- **Lubrication.** The engines, gearboxes, hydraulic units, bearings, and rollers on a ready mix truck require periodic lubrication. This lubrication can be performed onsite by company mechanics, offsite at company or vendor facilities, or onsite by vendor-supplied services.

- **Minor Repairs.** A large number of minor repairs of ready mix trucks are routinely handled onsite by mechanics. These include minor electrical system repairs, light changes, tire changes, etc.
- **Major Repairs.** Major repairs of ready mix trucks may be handled onsite, if the facility is equipped with a maintenance shop. Other facilities handle major repairs through strategically located regional repair facilities or through vendors.

### 3.0 POTENTIAL POLLUTANTS

#### 3.1 Overview

This section, Potential Pollutants, revisits the operational processes at ready mix concrete batch facilities, generally following the format of Section 1, Operational Processes. The potential pollutants associated with those operational processes and with the materials used in those operational processes are identified.

These pollutants are potential pollutants – pollutants that might enter an ecosystem if controls, i.e., Best Management Practices, were not applied. The list is exhaustive, and without ‘further qualification’ would indicate that ready mix concrete facilities are major polluters of surface water and groundwater. The ‘further qualification’ is the application of Best Management Practices, as presented in Section 3. By using Best Management Practices, ready mix concrete facilities do not degrade the environment. With proper application of Best Management Practices, any water which does leave the ready mix concrete facility, whether as surface water or towards groundwater, can be as pristine as when it entered the site.

#### 3.1.1 Fundamental Considerations

Several fundamental considerations facilitate an accurate understanding of potential pollutants at ready mix facilities.

#### 3.1.2 Suspended Solids

Suspended solids is one of the two most likely potential pollutants at a ready mix concrete facility (the other being pH changes).

The presence of suspended solids in water can often be treated, if needed, using physical methods, such as settling or filtration.

The materials used to manufacture ready mix concrete, with the exception of water and some admixtures, are all particulate in nature. The larger particles, such as coarse aggregates and larger fine aggregates, will settle in water. Conversely, the finer the particle, the more likely it will remain suspended in water, thereby becoming a suspended solids potential pollutant.

Though most aggregates are washed at the quarry or mine, most are received at the ready mix concrete facility containing some amount of very fine particles. In addition, as aggregate materials are handled in a ready mix concrete facility, they are subject to abrasion. Some processes are more abrasive than others, e.g., movement of aggregates using loaders, or driving over aggregates on the ground with truck or loader tires. Large and fine particles can become very fine particles, and larger particles can “shed” very fine particles through these abrasive operational processes.
Similar commentary can be applied to the handling of cementitious materials and particulate admixtures, although cementitious materials are more frequently handled in enclosed systems, and the amount (mass) of particulate admixtures is usually very low in comparison to the amount of aggregates handled.

In summary, the as-received condition of the materials and the materials-management devices and systems used in ready mix concrete facilities themselves (through abrasion) both contribute to the net mass of very fine particles at the facility – which if not correctly managed can contribute suspended solids as a potential pollutant. This consideration simplifies the following discussions of potential pollutants and drives many of the Best Management Practices of Section 3.

### 3.1.3 pH

pH change – always in the increasing pH direction (increasing alkalinity or decreasing hydrogen ion concentration) – is ubiquitous in the process water at ready mix concrete facilities. If not properly managed, pH change is the second of the two most likely potential pollutants at these facilities. pH change is due to the nature of most of the cementitious materials used in the facilities. Portland cement, flyash, and slag, when in contact with water, all drive the pH of the water higher.

Any operational process or materials-management device or system causing intentional or unintentional contact of cementitious material with water will change the pH of the water. This consideration simplifies the following discussions of the potential pollutants and drives many of the Best Management Practices presented in Section 3.

### 3.1.4 Dissolved Solids

Dissolved solids are solids that are variably soluble in water. Some carbohydrates and many salts are highly soluble in water and represent dissolved solids. Other solids that are variably soluble in water include metal ions.

Dissolved solids, unlike suspended solids, cannot be removed from water by physical processes, like settling or filtration. (Reverse osmosis is frequently considered a physical filtration process, but because it acts at the microscopic level, and because of its cost in the treatment of high volumes of water, it is not included in this manual as a potential Best Management Practice.)

Admixtures frequently contain complex carbohydrates and/or salts. Metal ions are present in some aggregates, some admixtures, and all cementitious materials. Likewise, older rusting equipment and various maintenance procedures (e.g., welding) can generate soluble metal ions.

Any operational process or materials-management device or system has the potential to contribute dissolved solids as a potential pollutant. This consideration simplifies the following discussions of the potential pollutants and drives many of the Best Management Practices presented in Section 3.

### 3.1.5 Petroleum Hydrocarbons

Petroleum hydrocarbons do not directly enter the manufacturing processes at ready mix concrete facilities. However, because of the universal presence of heavy equipment to deliver and handle materials and deliver the finished product, petroleum hydrocarbons represent a significant potential pollutant at these facilities.

Any operational process, materials-management device or system, or delivery vehicle has the potential to contribute petroleum hydrocarbons as a potential pollutant, either as a fugitive lubricant or fuel. This consideration simplifies the following discussions of the potential pollutants and drives many of the Best Management Practices presented in Section 3.
3.2 Aggregates

3.2.1 Aggregate Potential Pollutants

The potential pollutants associated with aggregates are metals and dissolved solids, suspended solids, and petroleum hydrocarbons.

3.2.2 Materials-Related Potential Pollutants

Two potential pollutants are related to the materials themselves.

- **Metals and Dissolved Solids.** Aggregates are sourced from the earth, and naturally contain metals as a component of the aggregate matrix. In some aggregates, these metals are slightly soluble. These metals exist as dissolved solids in water, and may therefore be present in water that is sourced from the aggregate stockpiles, whether the water is stormwater runoff or water used for moisture management.

- **Suspended Solids.** Aggregates, though “washed” at the aggregate source, naturally contain finer particles, including dust. The finest of these particles, may remain suspended in water as suspended solids.

3.2.3 Process-Related Potential Pollutants

The processes through which aggregates pass in a ready mix concrete facility – namely transportation, receiving, handling, and storage – each have the potential to either increase the suspended solids pollutant potential of the aggregates or to add additional potential pollutants related to the process.

- **Suspended Solids.** As discussed previously, materials handling processes, even those as seemingly benign as transfer by conveyor, have the potential to degrade aggregates through abrasion. The finer particles have the potential to remain suspended in water as suspended solids.

- **Petroleum.** As discussed previously aggregate delivery trucks, rail delivery equipment, loaders, conveyor gear boxes and rollers, are all fueled by and/or lubricated with petroleum products. These methods of transportation, receiving, storage, and handling all have the potential to affect site facility water with petroleum hydrocarbons.

3.3 Cementitious Materials

3.3.1 Material-Related Potential Pollutants

Potential pollutants associated with cementitious materials include pH change, metals, dissolved solids, suspended solids, and hexavalent chromium.

- **pH.** As discussed previously, cementitious materials, in water or aqueous environments, are strongly alkaline, driving the pH of water higher.

- **Metals.** Metals that are naturally present in the raw materials of Portland cement may be found dissolved in process water that contains Portland cement, though high pH tends to decrease the solubility of most ionic forms of metals. Likewise, metals that are native to the coal being burned in flyash-producing processes will be found in the flyash, and metals in slag-producing processes will be found in the ground granulated blast furnace slag sometimes used in ready mix concrete manufacturing.

- **Dissolved Solids.** Cementitious materials may contribute dissolved solids to process water in the form of soluble metals, as discussed above, or in the form of various salts (soluble cation/anion compounds).
• **Suspended Solids.** Cementitious materials are particulate in form; the finer particles may remain suspended in water.

• **Hexavalent Chromium.** Hexavalent chromium is present in many ready mix facility process water samples. The hexavalent chromium appears to be related to the manufacture of Portland cement.

3.3.2 **Process-Related Potential Pollutants**

The transportation, receiving, handling, and storage processes all have the potential to contribute the same potential pollutants to water – due primarily to spillage during handling – namely pH changes, metals, suspended solids, dissolved solids, and hexavalent chromium. In addition, the equipment used in these processes may contribute additional potential pollutants.

• **Petroleum Hydrocarbons.** Cementitious materials delivery trucks and rail delivery equipment are fueled by and/or lubricated with petroleum products. These methods of transportation, receiving, storage, and handling all have the potential to affect site facility water with petroleum hydrocarbons.

In addition, air emissions control equipment, if not properly maintained, may distribute cementitious materials to non-process areas of the site.

3.4 **Admixtures**

The use of admixtures, including batching and storage, might contribute the following potential pollutants to site water include:

• **Fibers.** Suspended solids – if the admixtures are spilled and degraded by facility traffic.

• **Mineral Admixtures.** Suspended solids, dissolved solids, and metals.

• **Color.** Suspended solids, dissolved solids, and metals.

• **Chemical Admixtures.** Metal cations; various anions such as nitrates, sulfonates, chlorides, etc.; various surfactants (soaps); and other dissolved solids.

3.5 **Water**

The presence and use of process water at a ready mix facility has the potential to contribute any or all of the potential pollutants previously listed, since the process water is generated during facility site processes. This process water likely contains elements of all ready mix concrete components – cementitious materials, aggregates, and admixtures.

The potential pollutants include pH change; suspended solids; petroleum hydrocarbons; and dissolved solids, such as hexavalent chromium, nitrates, chlorides, and various surfactants.

3.6 **Returned Material Management**

Returned material management, because it deals with the ready mix concrete in the uncured state, has the potential to contribute any or all of the potential pollutants previously listed.

The potential pollutants include pH change; suspended solids; petroleum hydrocarbons; and dissolved solids, such as hexavalent chromium, nitrates, chlorides, and various surfactants.

3.7 **Facility and Truck Maintenance**

Facility and truck maintenance has the potential to contribute any or all of the potential pollutants previously listed.
The potential pollutants include pH change; suspended solids; petroleum hydrocarbons; and dissolved solids, such as hexavalent chromium, nitrates, chlorides, and various surfactants. Maintenance of the equipment-intensive aspects of the manufacture of ready mix concrete is a necessary part of facility operations. The two are described below.

3.7.1 Facility Maintenance

Ready mix concrete facilities require constant maintenance.

- **Lubrication.** Rollers, gears, bearings, gates, etc. require periodic lubrication and/or change of lubricating fluids. Highly viscous greases and various types of gearbox and hydraulic oils are found at most facilities.

- **Steel.** The highly abrasive nature of the aggregate materials used in the manufacture of ready mix concrete accelerates the wearing-out of many steel surfaces throughout the ready mix plant. Maintenance crews routinely work to remove areas of worn steel (by cutting or torching) and replace the worn areas with new steel (by bolting or welding).

- **Hoses, Conveyor Belts.** The various rubber or synthetic rubber-like materials throughout the ready mix concrete facility are constantly being replaced, due to damage and wear.

- **Process Water Basin Maintenance/Sediment Removal.** The process water basins collect aggregates, cementitious materials, and water from plant processes. These materials need to be removed on a regular basis to maintain basin capacity. These materials are typically allowed to drain prior to offhaul for disposal. The materials may be placed so as to drain back into the process water basins, or may be placed in the area where return material is windrowed for beneficial reuse.

3.7.2 Truck Maintenance/Loader Maintenance

Ready mix truck maintenance occurs, to some extent, at every ready mix concrete facility where vehicles are domiciled. Many facilities perform only minor maintenance onsite, sending the trucks to in-company or vendor facilities for larger maintenance concerns.

- **Fueling.** Most ready mix delivery vehicles use diesel fuel. Fueling can occur through onsite facilities, offsite facilities, or vendor-supplied onsite services (a.k.a. “wet hosing”).

- **Lubrication.** The engines, gearboxes, hydraulic units, bearings, and rollers on a ready mix truck require periodic lubrication. This lubrication can be performed onsite by company mechanics, offsite at company or vendor facilities, or onsite by vendor-supplied services.

- **Minor Repairs.** A large number of minor repairs of ready mix trucks are routinely handled onsite by mechanics. These include minor electrical system repairs, light changes, tire changes, etc.

- **Major Repairs.** Major repairs of ready mix trucks may be handled onsite, if the facility is equipped with a maintenance shop. Other facilities handle major repairs through strategically located regional repair facilities or through vendors.
4.0 BEST MANAGEMENT PRACTICES
4.1 Bio/Filtration Basins
Bio/Filtration Basins

Applicability
- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description
A bio/filtration basin collects and treats stormwater runoff that has been minimally impacted by Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and Total Organic Carbon (TOC).

Stormwater runoff is routed to the basin, where it flows horizontally and vertically through a densely vegetated mat; through a permeable soil layer; and then into (a) a subsurface collection gallery, (b) the subsurface vadose zone, or (c) both. If the water has been collected into a collection gallery, the treated water is typically routed to a stormwater conveyance system.

The methods by which the basin treats impacted stormwater are further discussed in the Advantages section, below.

Targeted Constituents
- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes

Estimated Costs
- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Bio/Filtration Basins

Advantages

- **Passive System.** The bio/filtration basin is a passive measure for the treatment of minimally impacted stormwater. It functions through rainy cycles and seasons passively – continuous human oversight is not needed.

- **Multi-Modal Treatment.** The bio/filtration basin, as the name suggests, uses both biological and physical features to treat stormwater.
  
  o **Energy Dissipation.** As the stormwater flows horizontally through the vegetated mat, the foliage dissipates the energy of the flowing runoff. Water hitting the stalks and blades is diverted into a multitude of directions, enabling treatment throughout the basin, not just at the point(s) of entry. Redirecting water from a flowing stream into a radial flow greatly decreases the velocity of the water flow, and decreasing water velocity improves the settling of suspended solids.

  o **Physical Filtration – Vegetated Mat.** As the stormwater flows horizontally through the vegetated mat, the foliage filters the larger suspended particles from the stormwater.

  o **Physical Filtration – Vegetated Mat Growth Medium.** The soil used in bio/filtration basins is engineered, and is typically referred to as a sandy loam. As the stormwater runoff percolates vertically through the vegetated mat and into and through the growth medium, the medium provides an additional filtration mechanism, removing virtually all of the suspended solids. As with the sand filters used in potable water treatment systems, the growth medium will, in time, exhibit a non-uniform distribution of particles – typically with smaller particles having an increased presence in the upper areas of the medium. This naturally occurring non-uniform particle distribution enhances the filtration efficiently of the medium.

  o **Physical Filtration – Adsorption.** Many of the soluble potential pollutants in stormwater that are treated in a bio/filtration basin are removed because of their electron charges.
Bio/Filtration Basins

- Most metal ions are positively charged. Soil particles, while not necessarily carrying a net electron charge, often have an electron charge distribution, with negative charges being oriented near the surface of the soil particle. These negative and positive charges attract each other, and soluble metal potential pollutants are adsorbed to the soil particles.

- Likewise, the corresponding ions in most metal salts compounds carry a negative electron charge. At the base of the vegetation in a bio/filtration basin, there is typically a weak positive charge. Again, these charges attract each other and the soluble potential pollutants are adsorbed out of solution.

- In addition, as vegetation ages and discards plant material, a natural flocculent can be released – which also attracts negatively charged potential pollutants and removes them from solution.

- Finally, plants also utilize these soluble potential pollutants, incorporating them into the various matrices of their plant matter.
  
  - Biodegradation – Aerobic and Anaerobic. The root zones of plants are typically populated with various microbes, many of which are capable of biodegrading contaminants. Organic contaminants – such as certain organic admixtures and petroleum hydrocarbons – are amenable to biodegradation. “Lighter” hydrocarbons – such as lighter fuels and the resins found in some admixtures – can be degraded aerobically. “Heavier” hydrocarbons, such as oils and greases, can be degraded anaerobically. The root zones of plants have aerobic areas and anaerobic microzones, where minimally impacted stormwater will be treated for the presence of organic compounds.

- **Low Maintenance.** Depending on the vegetation used, the maintenance of bio/filtration basins can be very low. A basin planted with creeping red fescue grass needs to be mowed/trimmed only
Bio/Filtration Basins

once per year. An occasional application of a balanced fertilizer enhances the vigor of the vegetation.

Limitations

- **Capital Costs.** Bio/filtration basins are expensive to construct. As further discussed below, the materials used in building a bio/filtration basin are usually all imported from beyond the ready mix facility, and the number of equipment and man hours need to excavate the basin, lay out the collection gallery, cover the gallery with sand, place the engineered soil, install the irrigation system, and plant the vegetation is extreme.

- **Irrigation.** Depending on the vegetation used, moderate irrigation water will be needed to keep the basin healthy. Where available, recycled water, such as tertiary-treated water from a publicly operated treatment works (POTW), can mitigate the need to use municipal/well water for irrigation.

- **Stormwater-Specific.** This type of system cannot treat process water.

- **Minimally Impacted Stormwater.** Bio/filtration basins have a very long useful life, provided the stormwater being treated is minimally impacted. Stormwater with elevated pH will not be adequately treated in a bio/filtration basin. Stormwater with high concentrations of suspended solids can be adequately treated by the basin, however high suspended solids loading will eventually foul/clog the medium, and the porosity of the medium will be negatively affected.

Uses/Engineering/ Design

- **Engineering.** Engineering of a bio/filtration basin is required for several aspects of design.

  - Sizing. An engineered evaluation is needed in order to ensure that the basin is properly sized for area of the facility that drains into it. The square footage of the stormwater runoff area, periodic rainfall maxima, and the porosity of the medium all require evaluation by an experienced professional.
Bio/Filtration Basins

- Flow. If the basin is equipped with a collection gallery, the sizes of the pipes comprising the collection gallery and the impacts to the downstream stormwater conveyance system may require similar evaluations.

- Infiltration vs. Collection. If the bio/filtration basin is designed to allow the treated water to infiltrate the subsurface, a geotechnical engineering evaluation will be needed to ensure that the treated water infiltrates at an acceptable rate, and that the temporary storage capacity of the basin is sufficient for the severity of the rainfall event for which it is designed.

- It should be noted that engineering “shortcuts” are available; for example, the Contra Costa County Public Works Department has sponsored a web-based application for sizing of bio/filtration basins.

- **Siting Considerations.** Since the bio/filtration basin is likely to treat stormwater runoff from a sizeable portion of the ready mix facility, it needs to be sited appropriately. Likewise, means of conveyance to the basin from the other areas of the facility need to be considered – whether via overland flow through swales, or through pipes or trenches.

- **Space Requirements.** Designers of ready mix concrete facilities are typically challenged to fit all of the equipment (machinery), storage (e.g., stockpiles or aggregate ground-storage bins), truck and personal vehicle parking, control buildings, and common areas (lunch and meeting rooms) within the facility’s boundaries. Dedicating a substantial portion of the available facility square footage to a space-intense stormwater treatment structure can have implications that affect other operational features of the facility’s design.

- **Design.** With any type of bio/filtration basin, the implementation of the BMP begins with an engineered evaluation. This evaluation is presented in the BMP Water Balance Evaluation.
Bio/Filtration Basins

System Design. The construction of a bio/filtration basin begins with an excavation. The excavation will be sizeable, as the overall depth of the basin will include, beginning from the bottom:

- A reservoir layer. This layer would be present only in a bio/filtration basin for which the ultimate disposition of the treated stormwater runoff is infiltration to the subsurface. This layer may be several feet in depth.
- A collection gallery layer. This layer will hold the interconnected pipes of the collection gallery, embedded in washed aggregate.
- A bio/filtration media layer. This is the layer of soil which supports the growth of the vegetation.
- The vegetation.
- Freeboard. The sidewalls or banks of the bio/filtration basin may provide additional storage capacity for untreated stormwater during the most severe rainfall events. The banks of the bio/filtration basin should be sufficiently shallow – to mitigate the potential for erosion, and to permit safe access safe access to the basin for inspections and maintenance. A 3:1 rule is generally applied – meaning that a basin with four
feet of freeboard capacity will require an additional twelve feet of dimension in every direction to accommodate the sloped banks.

- **Construction.** Construction of the bio/filtration basin generally follows the following steps.
  
  - Excavation, as described above.
  - Impermeable Layer. For scenarios in which the treated stormwater runoff is not to infiltrate the ground, an impermeable layer is placed at the bottom of the excavation. Geotextile fabrics may blanket the impermeable layer, above and below, for protection of the impermeable layer from damage during construction.
  - Geotextile Fabric. For both infiltration-type and collection-type bio/filtration basins, a layer of permeable geotextile fabric is generally placed at the bottom of the excavation. The geotextile fabric prevents the migration of subsurface soils into the layers above.
  - Collection Gallery. For collection-type bio/filtration basins, a network of interconnected pipes is laid on the geotextile fabric.
    - The pipes are usually made of corrugated plastic or PVC, though perforated concrete pipes may also be used where strength is a concern.
    - The pipes are perforated, and the perforations are often oriented downward, so the treated water enters the pipe from below.
    - The collection gallery consists of one or more main trunk or conveyance pipelines. Lateral lines, often of smaller diameter, connect with the trunk lines at predetermined intervals with lateral lines.
    - The main trunk line(s) eventually connect to an outfall structure – which may be a concrete vault or another, non-perforated pipe.
    - The collected, treated stormwater runoff is then conveyed towards its final disposition. From the outfall structure, the
Bio/Filtration Basins

water may be conveyed to a stormwater conveyance system.

- Geotextile Wrap. The pipes of the collection gallery are frequently wrapped in a permeable geotextile fabric, which prevents the fouling of the perforations with gravel or soil.
  - Gravel Layer – Collection Gallery Bio/Filtration Basins. The collection gallery is embedded in gravel. The size of the gravel and the size of the collection gallery pipe perforations are typically matched to allow the free movement of water through the gravel and into the pipes. The gravel layer is generally extends several inches above the largest pipe.
  - Gravel Layer – Infiltration Bio/Filtration Basins. The gravel layer for an infiltration bio/filtration basin acts as a reservoir for the treated water. The stormwater runoff is likely to pass through the vegetation and filtration medium much faster than it infiltrates the subsurface. The gravel layer provides temporary storage for the treated stormwater runoff.

- Geotextile Fabric. Another layer of permeable geotextile fabric overlays the gravel layer, and prevents the upper filtration medium (soil) from migrating into the gravel layer.

- Filtration Medium. The filtration medium is an engineered soil comprised, usually, of a mixture of sand, top soil, and compost. The sand ensures permeability of the medium, while the top soil and compost provide the nutrients necessary for the health of the vegetation layer. The most typical specification for depth of this layer is a minimum of 18 inches.

- Irrigation System. To ensure the longevity of the vegetation layer, most bio/filtration basins are installed with an irrigation system. Depending on the type of vegetation planted, the irrigation may be aerial (spray-type) sprinklers or drip.
Bio/Filtration Basins

- Vegetation. The most-frequently planted vegetation for bio/filtration basins are grasses, while grasses, other groundcovers, shrubs, and trees are often planted for erosion control on the basin banks. There are numerous references available on the Internet for vegetation choices. The decision about which vegetation(s) to use necessarily takes into consideration climate; the availability of irrigation water; ease of maintenance; aesthetics; and resistance to standing water, climate extremes, and disease. Other considerations might include harvestability, commercial value, local agency requirements, and the potential for desired or undesired species to establish a habitat in the bio/filtration basin.

- Inlet(s) to the Bio/Filtration Basin. Most of the foregoing construction discussion has dealt with the management of stormwater runoff after it has reached the bio/filtration basin. An additional consideration in the construction of the basin is how the stormwater runoff gets into the basin.

  - Sheet Flow. Where feasible, stormwater runoff from the ready mix concrete facility should enter the basin via sheet flow. The potential for erosion of the basin banks is lowest when the runoff enters the basin along the length of one or more of its banks.

  - Point Source. It is frequently not feasible to direct stormwater runoff into a bio/filtration basin along the length of one or more of its banks. If the stormwater runoff enters the basin at one or more point sources – such as a drainage swale, a trench drain, or a subsurface pipe penetrating the basin bank, appropriate measures must be taken to mitigate the potential for erosion. Any measure that dissipates the energy of the point-source water will mitigate the potential for erosion. Such measures may include the strategic placement of coarse rock, the installation of a concrete slab as a spillway, the use of deeper-rooted shrubs at the point source, or distribution of the influent water through a perforated pipe along a greater distance within the basin.
Implementation/Maintenance

- **The Passive Nature of Bio/Filtration Basins.** Unlike many other BMPs used at ready mix concrete facilities for the management or treatment of stormwater runoff, bio/filtration basins – once established – can be uniquely free of the need for frequent periodic maintenance. The established and maintained bio/filtration basin is usually ready to treat stormwater runoff from an imminent storm threat without much more than a brief visual inspection.

- **Irrigation and Nutrients.** Both irrigation and nutrient needs are climate-specific and species-specific. At a minimum, irrigation should be installed to ensure the establishment of a healthy stand of vegetation when the bio/filtration basin is constructed, and may be needed throughout the life of the BMP. Nutrients, in the form of fertilizers, should be applied according to plant need, when plant uptake is likely to be rapid, and when the potential for transmittal of the fertilizer to stormwater runoff is unlikely.

- **Pruning/Mowing/Cutting.** Careful selection of the vegetation to be planted will minimize the need for pruning, mowing, or cutting. Many groundcovers need only infrequent attention; those that spread by rhizomes should be given special consideration since damage from environmental factors can be self-healing. A relatively popular, attractive groundcover for bio/filtration basins is grass – creeping red fescue remains green throughout the year, and requires trimming once in the spring.
Cost

- **Capital Costs.** As the foregoing discussion illustrates, the costs for implementation of this BMP are heavily weighted towards the capital required for design and construction, while the continuing costs for maintenance can be minimal if appropriate choices are made early in the design process. Costs for implementation of this BMP do not grow linearly with size of the project; economies of scale apply as the size of the project increases. Based on a 2008 installation by a northern California ready mix producer at a new facility, capital costs are estimated at $100,000 for the first acre of stormwater runoff managed using this BMP, with additional capital costs of approximately $60,000 for each additional acre managed. Costs for retrofitting an existing facility would be expected to be significantly greater.

- **Maintenance Costs.** The continuing costs for maintenance can be minimal if appropriate choices are made early in the design process. Based on a 2008 installation by a northern California ready mix producer at a new facility, maintenance costs average little more than the landscape maintenance costs for a similarly sized area.
Bio/Filtration Basins

Bio/Filtration Basin
Bio/Filtration Basins

Bio/Filtration Swale
4.2 Discharge to Local POTW
Discharge to Local POTW

Description

Many local Publicly Owned Treatment Works (POTW) are in favor of accepting concrete process water at their water treatment plants. The high pH water helps to neutralize the sewage wastes, which are typically acidic (low pH). Discharging off-site directly into the community sewer system can be a win-win for both the facility with limited process water storage capacity and for the POTW.

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes – depending on discharge permit conditions

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
- Operational $ -- depending on discharge permit conditions
Discharge to Local POTW

Advantages

- **Limits Liabilities of Discharges Off-Site as Stormwater.** By discharging the process water as needed to the POTW, a facility can assure that ample on-site storage for excess process water is available and that potential for overflows is minimized.

- **Reduces Space/Volume Necessary for Excess Process Water Storage.** By discharging to a POTW, a facility can minimize the need for large basins to contain all excess process water. However, if there is a solids limitation on the permit, basins may need to be designed for settling of the solids prior to excess process water discharge.

- **Low Maintenance.** Pumps and piping will need periodic maintenance. Sediment from the basins and/or storage system may need to be periodically removed.

Limitations

- **Capital Costs.** Costs for permitting, analytical testing, hook-up fees, piping, and potential tanks are moderate. Once the discharge permit has been issued, and the necessary infrastructure is in place, operational costs will be minimal – usually limited to analytical costs and fees assessed based on flow rates and constituent concentrations.

- **Water Use.** If discharging to a POTW, fresh water will need to be sourced from municipal supply or wells – in order to meet operational needs. This can be offset by reuse of process water in facility operations and discharging only when excess process water storage is getting full.

- **Solids Disposal.** As with all settling and containment basins, solids may need to be periodically removed and disposed of appropriately.

- **Effluent Limitations.** As mentioned above, the excess process water will need to meet effluent limitations. The effluent limitations may therefore necessitate pretreatment of the excess process water for reduction of TSS or pH adjustment.
Uses/Engineering/Design

- A plant located near sewer pipes that feed to a local POTW may be able to discharge its excess process water under permit to POTW. The community sewer systems are usually operated by municipal, county, or regional sanitation districts. POTWs are regulated by governmental agencies and must implement categorical pretreatment standards. These standards help the POTW to assure that the discharge into their system will not have an adverse effect on their system and will conform with their Waste Discharge Requirements issued by the Regional Water Quality Control Board.

- If the plant is to discharge excess process water to a POTW, contact with the POTW must first be initiated. The POTW’s discharge requirements may result in the need for pretreatment of the excess process water or may preclude the discharge entirely. Generally, an application form will need to be completed. The POTW may request analyses to determine if the excess process water meets effluent standards and permit requirements. If a permit is granted, facilities will have discharge limitations and requirements (possibly including sampling, analysis, and reporting).

- The limitations will be based on potential excess process water constituents and flow. These may include limits on petroleum products, solids content, discharge rates, heavy metals, oxygen demand, color, temperature, total dissolved solids, pH, etc. In some cases, the permit may only authorize discharges in batches and not authorize continuous flow. Each batch may require a limited analytical analysis prior to discharge. Discharges high in solids content may not be allowed or may be assessed a surcharge based on the amount of solids. Additionally, some POTWs will not accept excess process water that has been comingled with stormwater.

- Plant modifications necessary for implementing discharges to the POTW will include piping into their system and may include storage tanks and/or protection of the collection & storage areas from stormwater.
Discharge to Local POTW

- In some circumstances, excess process water can be trucked to the POTW. In these cases, prior arrangements will need to be made with the POTW.

**Implementation/Maintenance**

- Pumps and piping will require periodic maintenance.

- The basins and storage systems may need to be maintenance to prevent sediment buildup.

**Cost**

- Moderate costs will be required for permitting, testing, hook-up fees, piping and potentially additional tanks.

- Operational costs will be minimal, usually limited to analytical testing costs and fees assessed based on flow rate and constituent concentrations.
4.3 Formed Concrete Products
4.4 Housekeeping
Housekeeping

Applicability
- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description
Consistent housekeeping at a ready mix concrete facility will have beneficial effects for areas within and outside of the process water footprint. Certain pollutants make process water less attractive for reuse or treatment.

Inconsistent housekeeping will have a negative impact in the stormwater area; however, for purposes of this BMP, the following discussion is confined to the process water footprint.

Targeted Constituents
- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- Oil and Grease

Estimated Costs
- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
(see discussion under Limitations)
Housekeeping

Advantages

- **Reduce Track-Out.** Consistent application of good housekeeping practices will reduce transfer of contaminants from the process water footprint into stormwater portions of the ready mix concrete facility.

- **Promote Housekeeping Awareness.** Consistent application of good housekeeping practices keeps the site looking well-organized to visitors and reinforces good housekeeping skills to employees. Regular training on procedures keeps employees aware of the purpose and importance of maintaining good housekeeping.

- **Safety.** It has been proven that facilities with good housekeeping have safer work records, as slip, trip, and fall hazards are eliminated, or made easier to see and evade.

Limitations

- **Street Sweeper Costs.** Street sweepers can be purchased, or the service can be outsourced. If the unit is purchased, the capital cost can be substantial, and maintenance costs can be significant. If the service is outsourced, maintenance costs disappear, but the per-event charges can add up with time. Disposal of the swept-up material should be planned for, since offsite disposal can be expensive.

- **Air District Requirements.** Some air districts mandate sweeping as a BMP for control of emissions. It is recommended that the ready mix facility operator be familiar with air district requirements prior to commitment of capital for a sweeper purchase. For example, an air district in the south requires a particular type of PM-10 filtration.

Uses/Engineering/Design. Not applicable.

Implementation/Maintenance

Typical housekeeping procedures include training, sweeping paved areas, managing covered trash receptacles, secondary containment, maintaining spill response equipment,

- **Training.** Training is one of the most essential aspects of housekeeping. All personnel, including ready mix truck drivers, plant personnel (batchpersons, materials handlers), fleet and plant
maintenance persons, bulk delivery personnel (cementitious, aggregate, admixture, petroleum product, etc.), and outside contractors should be cognizant of facility operations. A basic tenet of this training should be “Recognize and Report,” i.e., if something doesn’t look quite right, it should be reported.

- **Sweeping.** Sweeping paved areas can be accomplished manually or with a street sweeper, depending on the facility size. It is recommended that sweeping be performed on a regular basis, and that a log of sweeping activities be maintained according to the various regulatory agency requirements.

- **Trash Receptacles.** Trash receptacles should be kept closed to prevent any water from getting into the container and leaching out possible pollutants. This also prevents wind from blowing trash or solids out.

- **Hazardous Materials.** At a minimum, hazardous materials containers should be kept closed, appropriately labeled, and properly stored according to applicable regulations.

- **Secondary Containment.** The purpose of secondary containment is to prevent leaking containers from contaminating process water or the process water footprint area. Secondary containment can take many forms, such as concrete curbing, double-walled tanks, retrofits to existing tanks (e.g., commercially available spill pallets or similar), or enclosed cargo containers. The specific form of secondary containment should be matched to plant use, container contents, and climatic conditions.

- **Spill Response.** Prompt response to spills is essential to reduce possible contamination within the process water footprint. Training employees to quickly respond to spills utilizing spill kits is essential. Spill response supplies provide dry clean-up methods for addressing spills or leaks of hazardous materials from equipment or trucks must be kept available, labeled, and protected. Employees should be familiar with the various procedures required to address different kinds of spills, such as petroleum products, hazardous materials, liquid color, admixtures, etc.
Housekeeping

- **Cementitious Spills.** Spills of cementitious materials occurring during delivery of these materials are a common problem at all ready mix concrete facilities. Because of the finely divided nature of these products, they can easily be wind-blown or tracked throughout the facility. Therefore prompt dry-cleanup methods must be employed as soon as any such spill is noted.

- **Neatness.** An extension of good housekeeping practices is the safe, orderly, and operationally efficient management of all materials, supplies, and equipment throughout the facility – from aggregates to dry admixtures to plant repair tools/parts to truck cleaning materials. Where feasible, storage should be protected from the weather. Appropriate and timely disposal of outdated and derelict materials and supplies should not be discounted.

**Costs**

- **Cost vs. Benefit.** Costs are highly site-specific. BMPs with higher capital or maintenance costs can frequently be amortized over several facilities, such as might occur with a single street sweeper used at multiple sites. Overall, the benefits of good housekeeping, such as enhanced safety and regulatory compliance, typically far outweigh the costs.
Housekeeping

Secondary containment for hazardous materials

Secondary containment for Admixtures
Housekeeping

Spill response equipment.

Trash receptacles closed.
4.5 Inspection and Maintenance
Inspection and Maintenance

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description

To ensure the process water management features and infrastructure is properly functioning, a comprehensive inspection and maintenance program should be implemented.

All inspection and maintenance activities must be documented to demonstrate compliance with the relevant permit requirements.

A well managed inspection and maintenance program will minimize the potential impact to surface water and ground water resources.

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- pH Changes

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $
- Low Maintenance $
Advantages

- **Reduces maintenance cost.** By actively inspecting and documenting the condition and performance of the process water management features and infrastructure, deficiencies will be identified early and allow for proactive and timely repairs.

- **Catches problems early.** By inspecting and documenting the condition and performance of the process water management features, potential non-containment of process water will be identified, basin over topping or process water non-containment can be quickly addressed to minimize potential down gradient soil impacts and/or potential impacts to surface and/or ground water.

- **Low Maintenance.** Daily inspections are part of the daily operation of any concrete plant and have the potential to minimize operational costs.

Limitations

- **Operations.** The inspections are limited to days the facility is operating and when employees are on-site.

- **Training.** Training is required.

- **Recordkeeping.** Current and accurate records need to be available according to permit requirements.

Uses/Engineering/Design

- The documented inspection program must be permit-compliant. Additional inspection is recommended, such as a detailed daily inspection of the process water containment area to identify signs of potential basin over topping or water releases. The inspection log should also include a list of the maintenance responses to correct any deficiencies observed.

Implementation/Maintenance

- The daily inspection log should be conducted each day of operation and must clearly list the following items associated with the process water management features and infrastructure, with a description of how they are functioning, and any remedial measures implemented.
Inspection and Maintenance

- Observe basin water level and adequate free board.
- Evaluate sediment accumulation vs. pond sediment capacity.
  - Inspect visible side walls (free of cracking or damage).
- Inspect visible concrete pads and sediment drying areas (free of cracking, appropriate drainage direction, adequate curbing).
- Observe surrounding soil surfaces for signs of overflow. Look for process water staining, erosion, sediments.
- Observe all means of process water conveyance, including pumps, piping, swales, curbs, and berms.

Cost
4.6 Mixer Truck Washout
Mixer Truck Washout

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description

The operative factor of good truck washout is to discharge all remaining concrete from the truck prior to washout. This will minimize the quantity of water necessary to achieve efficient drum cleaning. This also reduces the amount of cementitious solids in the resulting washout water and, therefore, proportionately reduces the TDS, TSS, and pH. Minimizing water use for washout also results in less process water that must be stored for reuse, treatment, or disposal.

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Mixer Truck Washout

Advantages

- **Useful at a Wide Variety of Facilities.** The reduction of solids in the truck drum prior to washout will be beneficial, to some degree, at almost all facilities. The best results will be achieved when used in conjunction with other BMPs, such as windrowing pad and a weired process water basin, where settled process water can be reused.

- **Simple concept.** The concept of “Empty Truck, Little Water” is easy to communicate. This will simplify the training process for plant personnel.

- **Moderate Maintenance.** If properly executed, a minimum washout program itself requires no maintenance. At a facility where no windrow pad or process water system exists; however, some system of handling the returned concrete removed from the truck prior to washout and properly storing and handling the process water must be implemented and maintained.

Limitations

- **Consistency of Execution.** Although the concept of “Empty Truck, Little Water” is simple, the repetitive training required to produce consistent results can sometimes be daunting. A system of training and monitoring must be set up that increases the time burden on an often already fully committed plant manager.

- **Must Be Part of an Overall Plant System.** Truck washout cannot be a stand-alone system. If all possible returned concrete must be removed from the drum prior to washout; it follows that some method of handling that material must first be in place. This can take many forms: a windrow pad, as already mentioned; block forms; or off-site disposal, such as a nearby recycling yard. Likewise, even the reduced amount of process water must have an in-place system to receive it.

Uses/Engineering/Design

- No direct engineering is required. However, as discussed above, the ability to remove and properly handle returned concrete from the truck prior to washout and properly contain the resulting process
Mixer Truck Washout

Water must be in place. These systems will often require engineering and design.

- **Process Flow Considerations.** For a truck washout system to be successful it must be convenient to use and fit into the overall process flow of the plant. Returned concrete removal, the source of the water used for truck washout, and the location of the process water discharge must all be in close proximity. If these components are widely separated, operating costs and the process water footprint will increase.

**Implementation and Maintenance**

- If properly executed, a minimum washout program itself requires no maintenance. At a facility where no windrow pad or process water system exists; however, some system of handling the returned concrete removed from the truck prior to washout and properly storing and handling the process water must be implemented and maintained.

**Cost**

- **Capital Costs.** Minimizing truck washout, by its self has no capital costs. However, as discussed above, associated returned concrete and waste water handling systems may require capital, if not already provided.

- **Maintenance Costs.** Maintenance costs in the form of employee training and management time can be significant. Please consult the Training BMP for further information.
4.7 Mixer Truck Water Use
Mixer Truck Water Use

Applicability
☑ All Facilities
☐ New Facilities
☐ Facilities Undergoing Significant Renovation
☐ Facilities Undergoing Minor Site Improvements

Description
Drivers are normally responsible for filling saddle tanks, adding water to the drum, exterior truck rinsing and truck washout (washout refers to truck drum interior rinsing). Overflows and excess water usage can overtax a process water management system and create problems of generating more water than the system was designed to handle. Municipal supply/well water can be very expensive if not properly controlled. Water management has a significant impact on efficiencies and costs. Effective BMPs, as described within, will help to reduce or eliminate these problems. Depending on the level of control desired, the cost to institute these BMPs ranges from low capital expenditures, to moderate capital expenditures.

Targeted Constituents
☑ Suspended Solids
☑ Dissolved Solids – Metals
☑ Petroleum Hydrocarbons
☒ pH Changes

Estimated Costs
☐ High Capital $$$
☒ Moderate Capital $$
☒ Low Capital $
☐ High Maintenance $$$
☐ Moderate Maintenance $$
☒ Low Maintenance $
Advantages

- **Prevents Overtaxing of the Process Water Management System.** Creating more water than the process water system was designed for is often difficult to manage. In some cases, this can result in off-site discharges of process water. Limiting the amount of municipal supply/well water spilled during saddle tank filling, exterior drum and truck rinsing, and minimizing the use of municipal supply/well in truck washout will help prevent overtaxing the process water system and reduce the potential for process water discharge.

- **Reduces Costs.** Municipal supply/well water can be very expensive, therefore, reducing excess usage of municipal supply/well water will decrease purchase costs, treatment costs, and make the plant more efficient. Likewise, minimizing the volume of process water that must managed by the process water system can reduce capital and maintenance costs and reduce the process water footprint.

Limitations

- **Capital Costs.** Some of the BMPs listed below have very low costs. More robust BMPs will require a moderate capital expenditure.

- **Level of Adherence.** As mentioned above, some of the BMPs have very low costs, such as driver training. The lower cost BMPs are more prone to human error. Technology based BMPs reduce the possibility of human error, but typically increase the costs.

- **Siting Considerations and Space Requirements.** Depending on which BMP is used, siting and space requirements will be limited.

Uses/Engineering/Design

The following BMPs can be used separately or in conjunction with each other to effectively manage water usage when filling saddle tanks, adding water to the drum, truck and drum rinsing, and truck washout.

- **Driver Training.** Drivers should be continually trained regarding appropriate water usage and the consequences of excess water usage. The training should focus on using just enough water to adequately get the job done.
**Mixer Truck Water Use**

- **Installation of Water Shut-Off Valves.** Conveniently located water shut-off valves on water hoses used to fill tanks is an effective tool to prevent over-filling of the tanks. For example, an automatic shut-off valve can prevent overflow to the truck's water saddle tank. As the tank fills with water, internal air pressure increases. When the air pressure reaches a certain level, a pressure switch activates an electric solenoid-actuated water valve that shuts off the water source. Likewise, spring-loaded shut-off valves can minimize water spillage.

- **Overhead Drum Filled With Metered Water.** Overhead drum filling stations (for load adjustment) help to ensure all water being added is directly discharged into the drum and not spilled outside the drum. Metered valves can be used to control the amount of water being added.

- **Use High Pressure, Low Volume Nozzles.** High pressure, low volume nozzles can be used during truck and drum rinsing to effectively limit the amount of water used. Computer controlled systems can be used with this and in conjunction with the overhead fill that restricts the amount of water that can be used.

- **Overhead Spray Bars.** Overhead spray bars, using high pressure, low volume water can also be used to limit the amount of water used for truck rinsing.

- **Capture Rinse Water for Reuse.** Truck rinse water is process water and can be reused for slump adjustment, for truck washout, or for batching. Depending on the solids content of the water needed for batching, the process water may need to be clarified, e.g., by filtration or using weired process water basins.

- **Limit Drum Rinse Water.** Mixer drums should be only rinsed as operationally necessary, such for changing mix designs, concrete colors, to limit buildup potential, or at the end of day. Reused process water should be utilized for truck washout and the amount of water should be limited to that which is operationally necessary, from 150 – 300 gallons for each drum washout. Too much water in the drum can reduce the cleaning action of the tumbling water in the drum. As with the BMPs listed above, installing flow control nozzles
Mixer Truck Water Use

on the water hoses at the rinse station and limiting washout time can minimize water usage.

- **Rock Out Drums**  See the “Rock Out” BMP as an effective way to reduce/eliminate water used for drum washout.

**Implementation/Maintenance**

- See Uses/Engineering/Design above.
- Maintenance will be low to moderate depending upon the specific BMP activities that are implemented.

**Cost:**

- Costs will be low to moderate depending upon the specific BMP activities that are implemented.
4.8 Process Water Reuse
Process Water Re-Use

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description

The re-use of process water in ready mix concrete facility batch processes is fundamental in the management of process water. In the absence of beneficial re-use, a facility’s only other option for the disposition of process water may be discharge to a sanitary sewer system.

Various aspects of well-planned capture, containment, and possible treatment of the process water are covered in the other BMPs in this manual. The scope of this BMP is to provide a high-level overview of a process water re-use plan.

Water other than tap can be used as mix water in ready mixed concrete but the producer must follow procedures in ASTM C1602 and ASTM C94 in order to ensure its quality meets standardized limits.

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Process Water Re-Use

Advantages

- **Water Conservation/Costs.** Many facilities either purchase source water or pump it from wells. Using process water from ponds reduces or eliminates purchased water and reduces pumping costs from deep water wells. The reuse of storm water also reduces drawdown from groundwater aquifers and/or conserves water treated from human consumption.

- **Reduces the Potential Off-Site Discharges of Co-Mingled Water.** Containing process water and reusing it will also help to ensure that storm water is not co-mingled with process water and allowed to discharge off-site. Re-using process water helps to draw down stored water in the containment structures, thus minimizing the possibility of overtaxing these structures and having an unauthorized release of process water.

- **Low Maintenance.** Depending on the system used, the maintenance of a process water reuse system can be low. Pumps and piping will need to be periodically maintained. Specific gravity meters will need to be calibrated and periodically maintained as well. Weired basins will need to be cleaned periodically – and storage tanks may likewise require periodic cleaning.

Limitations

- **Capital Costs.** Costs for the piping, pumps, specific gravity meters, and control board modifications are moderate. Tanks may also be used in conjunction and are also moderate expenses.

- **Size and Siting Requirements.** The size requirements for this process are minimal – with the exception of weired basin installation. For the most part, existing basins can be used with the addition of plumbing apparatuses. In some cases, additional tanks may need to be employed, which will add to the space requirements.

- **Quality Control.** As mentioned above, the water should be analyzed by checking for any impurities that may adversely affect concrete quality in accordance with ASTM C1602 and ASTM C94.
Process Water Re-Use

Uses/Engineering/Design

An article published by the NRMCA and reprinted with permission regarding the technical aspects of process water reuse is included as Appendix 3 to this document.

- **Process Water Minimization.** The volume of process water generated should be limited using all available technologies and practices. Process water minimization is accomplished through:
  
  o Process Water Footprint Minimization. The smallest feasible footprint for process water generating operations at a ready mix facility will minimize the volume of process water generated during rainfall events.
  
  o Facility Layout. By locating process water generating operations within close proximity to each other and to the ready mix batch plant, space is economized and the amount of process water generated from rainfall events will be minimized as well.
  
  o Hoses. By limiting the flowrate at truck rinse areas – optimally by replacing hoses with pressure washers – the amount of process water generated can be reduced dramatically.
  
  o Washout. By utilizing captured and contained process water to wash out the ready mix truck drums, the amount of process water generated can be reduced dramatically.

- **Process Water Treatment.** Process water contains substantial quantities of fine material – which consists of various cementitious and fine aggregate particles. The presence of the particles in higher concentrations can have a detrimental effect on ready mix concrete: these particles may unacceptably increase the rate of curing of the concrete. In addition, this fine material can contribute to the weight of the finished product. Treatment options include:
  
  o Clarification. The use of properly designed weired clarification basins can reduce the concentration of suspended solids in process water to acceptable levels.
  
  o Filtration. Various types of filtration mechanisms are available to remove suspended solids from process water. These can be expensive to install and maintain.
Process Water Re-Use

- Retardation. Most ready mix facilities inventory a retarding admixture for use in ready mix concrete. Addition of retarder to solids-containing process water can offset the set-accelerator characteristic of suspended-solids-containing process water.

- **ASTM Guidelines.** ASTM has published standards for the reuse of process water in ready mix concrete operations. Because of copyright considerations, these standards are not reproduced here; the reader is referred to the ASTM website for the purchase of these standards. ASTM C1602 and ASTM 92 are the applicable standards.

**Implementation/Maintenance**

See Uses/Engineering/Design

**Cost**
Process Water Re-Use

Process Water Equipment for Washout of Mixer Drum
Process Water Re-Use

Ready Mix Truck Receiving Reclaimed Water for Washout
4.9 Process Water Segregation-Permanent
### Applicability

- [ ] All Facilities
- [x] New Facilities
- [x] Facilities Undergoing Significant Renovation
- [ ] Facilities Undergoing Minor Site Improvements

### Targeted Constituents

- ✪ Suspended Solids
- ✪ Dissolved Solids – Metals
- ✪ Petroleum Hydrocarbons
- ✪ pH Changes

### Estimated Costs

- [ ] High Capital $$$
- [x] Moderate Capital $$
- [x] Low Capital $
- [ ] High Maintenance $$$
- [ ] Moderate Maintenance $$
- [x] Low Maintenance $

**Description**

Process water segregation employs permanent or semi-permanent physical constructs to segregate excess process water from stormwater falling on areas not impacted with cementitious materials. These physical constructs may consist of grade breaks, drainage swales, and roll curbs or formed curbs.

Mechanical devices, usually pumps, may be necessary to move water between or among areas where process water collects.

This practice can be implemented during the design and construction phases for new facilities; or during design, demolition, and reconstruction phases, for facilities undergoing significant renovation.

Similar practices for facilities undergoing minor site improvements are considered under a separate BMP.
Advantages

- **Passive System.** If properly designed and implemented, the physical constructs or improvements necessary to effect process water segregation function passively.
  
  o Process Water Areas. Excess process water and stormwater falling on these areas are passively diverted to collection and storage – for ultimate reuse in batch processes.
  
  o Non-Process Water Areas. Stormwater falling on areas without cementitious material impacts is likewise passively diverted – but to other areas – for collection and possible storage, treatment, and discharge or subsequent use.
  
  o Integration with Other BMPs. When the design of process water segregation features is coordinated with the design of certain other BMPs, such as process water footprint evaluation and confinement, weired process water basins, bio/filtration basins or swale designs, the integrated water management systems enhance the passive function of process water segregation feature. Conversely, in the absence of good design considerations, individual components of the integrated water management system can be overwhelmed by the flows of water from either the process areas or the low-impact areas – resulting in comingling of excess process water and stormwater runoff.

- **Low Maintenance.** The process water segregation features in new facilities and in facilities undergoing significant renovation are typically permanent or semi-permanent. For example, a grade break, curb, or drainage swale built in to a paving design typically survives the rigors of plant operations for many years.

- **Low to Moderate Cost.** The low-to-moderate-cost evaluation for process water segregation features presupposes that (in new facilities or in facilities undergoing significant renovation) an area in which a grade break, curb, or drainage swale is to be installed would otherwise be receiving a paving treatment. In such a scenario, the additional cost to implement process water segregation would consist
of an incremental engineering cost and an incremental cost in the pavement placement and finishing.

Limitations

- **Engineering.** The primary limitation to effective process water segregation as presented in this BMP is the need for engineering evaluations early in the design phase.

Uses/Engineering/Design

- **Engineering.** For proper design and implementation, the physical constructs or improvements necessary to effect process water segregation require engineering evaluation(s).
  
  o **Sizing.** The sizing of downstream collection, storage, and/or treatment systems for the flows of water generated from inside and outside of process water segregation features require an engineering evaluation that includes the intensity (both duration and rainfall rate) of periodic rainfall maxima, aerial extents of process water and low-impact stormwater runoff collection areas, and operational cycles (for consideration of the amount of collected water that can be reused in batch plant processes). Note that comprehensive site water management evaluations are presented in BMP – Water Management Evaluation.

  o **Flowrates.** The flowrates of water being directed to collection, storage, and/or treatment systems will determine the necessary sizing of conveyance swales and/or pipes. Water flows entering storage and/or treatment systems at flowrates greater than design could cause scouring of non-paved areas, excessive transport of suspended solids, and overwhelming of treatment systems.

- **Elevations.** A primary consideration for design of a process water segregation feature is elevation. The elevation of the grade break or top of the curb should be greater than the elevation of the ultimate collection/storage feature (e.g., in-ground basin), and accommodate a minimum slope of one to two percent from the feature to the basin. Additional elevation may be required to allow some freeboard water storage capacity, depending on the design criteria for total storage capacity.
Process Water Segregation Permanent

- **Traffic.** A secondary consideration for design of a process water segregation feature is the type of traffic it must be able to withstand and allow to pass. If delivery vehicles, loaders, and/or parking lot sweepers are to pass over the feature, then the feature should either be a grade break or a roll curb. In areas where vehicle traffic is not a concern, but where freeboard capacity may be, a traditionally formed curb, integral or sealed to the surface beneath, is an alternative worth considering.

- **Construction.** Construction of a process water segregation feature is straightforward:
  - Grade Break. If the process water segregation feature consists of a grade break, then it, and the accompanying slopes away from it, are designed into the paving, and likely into the underlying grading.
  - Curb. If the process water segregation feature consists of a curb (whether roll or formed), then the curb may be poured integral to the paving surface. Alternatively, the curb may be poured or tooled on the surface of the underlying paving. If poured or tooled on the surface of the underlying paving, a seal between the two is recommended if ponded water is expected on either side of the feature. If traffic over the roll curb is expected, underlying pavement may need to be notched to prevent movement of the curb.

Implementation and Maintenance

- **Integrity.** Permanent or semi-permanent process water segregation features require little maintenance. Periodic inspections need to be performed to ensure integrity. Elevation or grade breaks built into existing paving design require virtually no maintenance. Roll curbs and formed or tooled curbs should be regularly inspected – as part of the SWPPP inspection protocol – for wear, breaks, and movement.
All Cementitious Process Activities Occur within Containment Area
Process Water Segregation Permanent

Cost

- **Low to Moderate Capital Costs.** The costs for implementation of this BMP are only incremental when the process water segregation features are incorporated into the overall facility design early in the planning process.

- **Low Maintenance Costs.** Maintenance costs are very low and usually consist of inspection and cleaning.
Process Water Segregation Permanent

In-Ground Process Water Capture Trench
Grade Break for Process Water Containment (from above)
Grade Break for Process Water Containment (from above)
4.10 Process Water Segregation - Temporary
Process Water Segregation Temporary

**Description**

The process water segregation presented in this BMP employs temporary measures to segregate excess process water from stormwater falling on areas not impacted with cementitious materials. These measures may consist of sand bags, excavated (dug) trenches, temporary curbs or booms, temporary process water storage, etc.

Mechanical devices, usually pumps, may be necessary to move water between or among areas where process water collects.

This practice is typically implemented in advance of an impending storm or in response to heavier-than-expected rainfall.

Similar, more permanent practices for facilities more undergoing substantive site improvements are considered under BMP – Process Water Segregation – Permanent.

**Applicability**

- [ ] All Facilities
- [ ] New Facilities
- [x] Facilities Undergoing Significant Renovation
- [x] Facilities Undergoing Minor Site Improvements

**Targeted Constituents**

- ✤ Suspended Solids
- ✤ Dissolved Solids – Metals
- ✤ Petroleum Hydrocarbons
- ✤ pH Changes

**Estimated Costs**

- [ ] High Capital $$$
- [x] Moderate Capital $$
- [x] Low Capital $
- [ ] High Maintenance $$$
- [x] Moderate Maintenance $$
- [x] Low Maintenance $
Advantages

- **Responsive.**
  
  o These measures are typically implemented in response to a severe weather event or threat, such as extended rainfall duration or high rainfall intensity. Under these conditions, a threat may exist for process water collection and containment systems to reach capacity—resulting in the potential for contamination of stormwater runoff in areas of the facility that are not integral to the process water runoff area.

  o In response to the severe weather event or threat, the facility operator may implement these measures to mitigate the potential for impacts to stormwater runoff. Under less severe weather conditions, these measures can remain safely stored or unused.

- **Low Capital Cost.** These measures are typically ‘low tech’ and as such require only the most basic of knowledge, planning, and capital outlay. Burlap bags, sand, shovels, pumps, hoses, and empty ready mix delivery trucks are usually among the basic equipment and materials available at any ready mix concrete facility.

Limitations

- **Implementation Costs.** Responsive measures such as these are typically labor-intense. On an inclement weather day, when the ready mix facility might otherwise be unstaffed or minimally staffed, implementing these measures will likely require the presence of at least one laborer, a truck driver, and a manager.

- **Facility Operations Effects.** These measures should not replace more permanent measures for the control of process water and runoff from process water runoff areas. Sand bags and temporary curbing can interrupt regular facility operations, as can ready mix trucks that have been filled with excess process water.

Uses/Engineering/Design

- See above. Engineering and design are minimal.

Implementation and Maintenance
• **Sand Bags and Temporary Curbing.** Sand bags and temporary curbing are used to segregate water falling on process and non-process areas, or to divert minimally impacted or non-impacted stormwater runoff from process water collection and storage structures. Under severe or extended rainfall events, particularly when the ready mix facility has been closed due to the inclement weather, the ‘first flush’ of rainfall runoff within a process water runoff area has likely rinsed the runoff area of potential pollutants, particularly if housekeeping BMPs were implemented prior to the beginning of the rainfall event(s). Additional stormwater runoff in many of these areas can be diverted from flowing into the process water basins, and thereby be redirected to the same disposition as stormwater runoff from non-process water runoff areas.

• **Temporary Storage/Containment.** If process water collection and storage systems are reaching capacity, it may be necessary to remove some of the process water from the structures and place it into temporary storage. The infrastructure (pumps, hoses, and pipes) used for ready mix truck mixer drum rinsing can move process water from the collection and storage structures to temporary containment, such as in a mixer truck. A 10-cubic yard mixer drum can hold in excess of 2,200 gallons of process water. Some facilities also have empty above-ground poly tanks available that can be used for excess process water storage. Still others bring in rental tank trailers for use through the wet weather season.

• **Damage & Degradation.** Temporary process water segregation measures are subject to degradation from handling, from weather, and from being driven over. They should be stored, when not being used, in protected areas, and should be inspected before and during use for damage.

• **Silting.** During periods of extreme rainfall, process water being pumped into temporary storage may have significant suspended solids. These solids will settle with time, and may be difficult to remove from a temporary storage tank or container.

**Cost**
• **Capital Costs/Maintenance Costs.** The costs for implementation of this BMP range from low to moderate, depending on the measures implemented. For sand bags or temporary curbing, the costs are low; conversely, rental trailer tank storage of excess process water can cost upwards of $1,000 per month for each 20,000-gallon tank rented.
Temporary Roll Curb
Process Water Segregation Temporary

Temporary Process Water Capture/Containment for Reuse
4.11 Reclaiming Systems
Description

Mechanical reclaiming systems manage returned/excess concrete by separating aggregates from cement/water slurry. A well-managed and maintained system allows for all constituents in the concrete (including the cement/water slurry) to be individually recycled.

Excess concrete is typically discharged into a hopper which feeds into a screening system that washes and separates the aggregates from the cement/water slurry. Secondary screening may separate the aggregates by size into coarse and fine.

The cement/water slurry that is left can be further processed by settling or clarification – the water can either be recirculated back to the reclamer to wash incoming material or, if of sufficient quality, can be used in batch processes.
Reclaiming Systems

Advantages

- **Cost Savings.** Reclaimers can provide significant savings depending on site-specific operations. The reclaiming of aggregate produces high quality material since it has been re-washed and can be blended directly with production aggregate storage.
  - Reclaimers reduce the cost of purchased aggregate and sand.
  - Reclaimers reduce the cost of hauling returned concrete to a disposal or recycling facility.
  - A cost analysis can be used to determine if a mechanical reclaiming system is cost effective for a specific operation. The capital and maintenance costs should be off-set by the savings of reclaiming aggregate. The analysis should take into consideration the delivered cost of aggregate and the cost for disposal of returned concrete.

- **Process Water Footprint Reduction.** When functioning properly, some reclaimers can reduce the overall area required for the management of process water.

Limitations

- **Potential Limitations.** Reclaimers, if not properly engineered and integrated with other existing or proposed facility elements, can present several limitations. Many of these potential limitations can be minimized or eliminated with adequate planning and engineering. These potential limitations include time and throughput constraints, site considerations, weather influences, effects on mix designs, and solids drying characteristics. These potential limitations are further discussed in the Uses/Engineering/Design section, below.

Uses/Engineering/Design

- **Time and Throughput Constraints.** Reclaimers have throughput specifications that may limit the time it takes to unload concrete. Consideration should be made of the capacity of the system before purchase, particularly if a cement-water slurry tank is utilized to
Reclaiming Systems

clarify the water. An appropriate system should be designed specific to an operation to avoid delays in production.

- **Site Considerations.** Reclaimers on their own do not have a large footprint, however, in most cases they should ideally be collocated adjacent to the weirded process water basin or other process water management system. The addition of a clarifying slurry water tank and associated admixture storage will also increase the footprint of the system.

- **Weather Influences.** Reclaimers require a significant amount of water to operate. Operation can be difficult during winter seasons if the process water management system is already stressed.

- **Effects on Mix Designs.** The solids content of the cement/slurry water, even after clarification, may have predictable but undesirable effects on the ready mix concrete characteristics.

- **Solids Drying Characteristics.** The settled, dewatered cement fines take considerable time to dry. Additional space and/or weather protection will likely be required.

**Implementation/Maintenance**

- Reclaimers require regular equipment maintenance as well as process management of the system to ensure that the drivers do not overload it.

**Costs**

- **High Capital Costs.** Mechanical reclaimers are available with varying throughput capabilities that are correlated to both plant throughput and fleet size. Virtually without exception, reclaimers will require high capital costs to purchase and install.

- **High Maintenance Costs.** Reclaimers require regular equipment maintenance as well as facility operator management of the process. A well managed system will require additional time from employees or may require a dedicated employee to ensure the system is used and maintained properly and not overloaded by the drivers.
4.12 Returned Concrete Rubble Pile
Returned Concrete Windrow

Description

Many concrete producers process returned concrete by allowing it to cure to a hardened state prior to beneficial reuse as a component of a manufactured aggregate base.

This BMP discusses proper methods for pouring the concrete into long narrow piles (windrows) that will promote quick hardening of the returned concrete and allow for easy pickup and placement into a rubble pile for further processing (on-site or off-site).

Applicability

☑ All Facilities
☐ New Facilities
☐ Facilities Undergoing Significant Renovation
☐ Facilities Undergoing Minor Site Improvements

Targeted Constituents

⊕ Suspended Solids
⊕ Dissolved Solids – Metals
⊕ pH Changes

Estimated Costs

☐ High Capital $$$
☐ Moderate Capital $$
☑ Low Capital $
☐ High Maintenance $$$
☑ Moderate Maintenance $$
☐ Low Maintenance $
Returned Concrete Windrow

Advantages

- **Reduces disposal cost.** On-site curing and processing of returned concrete makes the returned material much easier and less expensive to handle.

- **Recycles a waste product into a beneficial product.** By using returned concrete to create aggregate base, a potential waste product is diverted from landfill and is converted to beneficial reuse.

- **Conservation of Natural Resources.** Reuse/recycle of returned concrete in aggregate base offsets the need for mined or quarried material. This offset can have LEED accreditation value.

- **Low-to-Moderate Maintenance.** Depending on the area used, this windrowing area can be designed for low maintenance, by installing impervious surfaces that drain to managed concrete basins. However, using a lower-capital-cost compacted-soil windrowing area would increase the need for routine maintenance due to the permeable nature of the surface, which could increase potential impacts to groundwater. Under any scenario, the windrowed concrete must be removed to the concrete rubble pile in a timely manner.

- **Capital Cost.** Capital costs are site-specific and can vary significantly depending on such considerations as 1) existing site surfaces, 2) available space, 3) depth to groundwater, 4) location, 5) climate, etc.

Limitations

- **Size and Siting Requirements.** The size of the system used for the collection of returned concrete can be relatively large and many facilities may not have adequate space available. A pad large enough to windrow the returned concrete into long narrow piles requires significant space. This pad must also have truck access and be located near a concrete rubble pile or loading area for off-site disposal.
Returned Concrete Windrow

- **Design.** The windrowing area, regardless of the surface, needs to be able to withstand the type of traffic and abuse it will receive during placement and additional handling of the returned concrete. Considerations for prevention of stormwater run-off and run-on may necessitate curbs, swales, berms, and basins. Considerations for process water containment may likewise necessitate the curbs, swales, and berms, as well as proper grading, impermeable surfaces, and concrete basins.

**Uses/Engineering/Design**

- Returned concrete need not be a waste but can have value, if properly processed, as a construction aggregate component. Typically, it is allowed to harden then processed by a crushing and screening plant for sale as a Class II Road Base material.

- To facilitate the proper handling of the returned concrete, it should be poured from the ready-mix concrete truck into a long narrow pile, commonly called a windrow. This makes the piles of cured concrete smaller and easier to manage.

- Ideally, the windrows should be placed on a concrete surface. This practice provides additional protection for groundwater resources. The concrete surface should be graded to prevent stormwater run-off and run-on. Free-draining liquids from extremely high slump returned concrete or from truck/chute-rinsing activities should drain to a concrete-lined basin.

- The windrows can also be placed on compacted soil surface provided that potential impacts to groundwater are negligible. A compacted soil surface is not designed to receive returned concrete that may leach free liquids, nor should it receive process water from truck or chute rinsing.

- The windrowed concrete should be gathered and placed into the returned concrete rubble pile or shipped off-site in a timely manner. Stormwater run-off and/or infiltration from uncured concrete must be prevented or collected.
Returned Concrete Windrow

Implementation/Maintenance

The windrowed concrete area should be visually monitored regularly to ensure BMP requirements are being met.

Cost
4.13 Rock Out of Mixer Truck Drums
Rock-Out of Mixer Truck Drums

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description

Rocking-out is a procedure used for cleaning the insides of mixer-truck drums using no water. Aggregate or sand is added to the drum and rotated to clean concrete residue from the drum. The aggregate/residue mixture is discharged and recycled.

At this time, this is not a widespread practice in the State of California.

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Rock-Out of Mixer Truck Drums

Advantages

- **Water Conservation.** Virtually eliminating water uses for mixer truck drum washout will conserve approximately 300 gallons of water per truck.

- **Settling Basin Management.** Eliminating drum washout into the settling basin helps to avoid overtaxing the system with excess water and concrete paste. Based on the amount of water used for washout listed above, a facility with 50 trucks could reduce the amount of water discharged into the settling basin by approximately 15,000 gallons per day. In addition, this practice will reduce the frequency of cleaning concrete paste out of the settling basin and reduce the operational costs associated with handling and disposal of paste. A new facility may also be able to design and construct a smaller settling basin system if they commit to the rock-out procedure.

- **Reduced Drum Chipping.** Some reports indicate that the rock-out procedure does a better job of “scrubbing” the drum clean than does water, thus reducing the amount of drum chipping needed.

Limitations

- **Space Requirements.** Windrowing the coarse aggregate for recycling into base material will utilize a significant amount of space at the facility. Blending the coarse aggregate back into the virgin feedstock will utilize much less space as there only needs to be room to hold coarse aggregate generated during the previous operating day.

- **Increased Hauling.** Facilities that are not co-located with a recycle plant or do not have enough available space to periodically bring in a portable recycle plant will be required to haul the coarse aggregate off-site. The cost of the haul could be off-set by backhauling virgin aggregates if the source facility also has a recycling operation.

- **Rock vs. Gravel.** It has been reported that gravels are significantly less effective at rock-out cleaning of truck drums. Crushed rock is the material of choice.
Rock-Out of Mixer Truck Drums

Uses/Engineering/Design

• **End of Day.** After the final load delivery of the day (or after waiting at the jobsite for an extended period) for each truck, all returned concrete is windrowed or run through a reclaimer. Approximately 1,000 pounds of coarse aggregate is added to the drum and the drum is rotated at a relatively high rate to clean the inner portions of the drum. If the plant is co-located with an aggregate plant, 1,000 pounds of off-spec coarse aggregate can be an acceptable material for use in cleaning the drum. The material is discharged for later recycling. The chutes should not be rinsed in this area and should be rinsed into a reclaimer or process water collection basin. This discharged material can be used to produce recycled aggregate base rock.

• Alternatively, the material can be stockpiled and blended back into the coarse aggregate feedstock the next day. In this case, the loader operator must be attentive to blend the material into the virgin feedstock in small amounts at any one time to avoid having excess drum residue material into the batch. The loader operator may also need to keep the stockpile agitated to avoid the material from getting overly hardened.

• **Change of Colors.** In the event that a mixer truck is transporting concrete that is a different color than the previous load, the procedure above could be followed, but instead of using 1,000 pounds of coarse aggregate, 2,000 pounds of sand is used to replace the coarse aggregate.

Implementation/Maintenance

• Minimal maintenance is required.

Cost

• **Low to Moderate.** Costs for this procedure are generally off-set by reduced water consumption, reduced water pumping, reduced paste management, and possible reduced chipping. Hauling coarse aggregate off-site will increase the costs considerably.
4.14 Schmutz Drying Pad/Basin Cleanout
Schmütz Drying Pad

Applicability

- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description

A Schmütz Drying Pad refers to a designated area where solids removed from the site process water basins can be safely stored to drain for later re-use or disposal. The area must be lined with concrete and be sloped or bermed so that any run-off water will be contained within the area or channeled back to the process water basin.

Targeted Constituents

- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes (Note: This BMP does not effect pH directly, however, a pH reduction circuit can be appended to this system)

Estimated Costs

- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Advantages

- **Can Be Retrofitted Onto an Existing System.** A Schmütz Drying Pad can be retrofitted onto any existing process water containment system. The best results will be achieved when used in conjunction with a windrowing pad and a weired process water basin. However, older systems with deep process water basins can be improved with the addition of a contained drying pad for excavated solids.

- **Moderate Maintenance.** The amount of maintenance required for a Schmütz Drying Pad will greatly depend on the type of process water system that it services, but regardless of the type of system, the cost of maintaining a Schmutz Drying Pad will be minor to moderate.

Limitations

- **Must Be Part of an Overall Plant System.** A Schmütz Drying Pad cannot be a stand alone system. It must be part of a process water containment system, such as a weired process water basin.

- **Must Be Well Managed.** Because of the fine-grained nature and water content of the material, considerable time is required to dry/dewater. If wet solids are not carefully handled, housekeeping challenges will arise, and the management of the drying solids will become more complicated.

Uses/Engineering/Design.

- **Design.** The design of the Schmütz Drying Pad requires the following careful considerations:
  - The pad can be subdivided, so some solids can dry and dewater, and freshly excavated solids can be placed into the second area, if needed.
  - The pad and associated walls should be design to hold the maximum expected quantity of excavated solids.
  - The pad should be located and sloped so all runoff is captured and contained, preferably into the process water basin.
  - The pad should be located and designed to prevent stormwater run-on.
The area should be lined with concrete.

- No professional engineering is likely needed. However, as discussed above, the ability to remove and properly handle returned concrete from the truck prior to washout and properly contain the resulting washout water must be in place. These systems will often require site specific engineering and design.

- **Process Flow Considerations.** A Schmütz Drying Pad, as well as a windrow area, and a weired process water basin will require the least management and will function most efficiently if they are located in close proximity to each other and function as a unit.

**Implementation/Maintenance**

- Maintenance for a Schmutz Drying Pad is dependent on the type of water system that it services. A weired process water basin system with windrowing pad and minimal washout will produce a relatively small amount of waste solids, and require less maintenance. However, a deep process water basin that receives a large amount of solids between cleanings will generate a large amount of fine grained “paste.” This will require a larger area for the Schmütz Drying Pad, and a longer time for the fine material to drain and dry.

**Cost**

- **Capital Costs.** Installation cost of a Schmütz Drying Pad will vary. Simple systems may consist of a dedicated portion of an existing lay-down pad. More elaborate, and hence more costly, systems may consist of a concrete pad with “bin block” walls. Most costly will be a reinforced pad and formed walls.

- **Maintenance Costs.** Maintenance costs for a Schmütz Drying Pad are minimal to moderate, consisting of normal housekeeping and repair.
Single bay Schmütz drying pad built on a concrete using “Bin Blocks”
Two-bay Schmütz drying pad, one bay used for color washout only.
4.15 Storm Water Utilization
Stormwater Utilization

Applicability
- All Facilities
- New Facilities
- Facilities Undergoing Significant Renovation
- Facilities Undergoing Minor Site Improvements

Description
Many concrete producers have means to capture stormwater and use it for a variety of applications in the production of ready mixed concrete. Water other than municipal/well can be used as mix water in ready mixed concrete but the producer must follow procedures in ASTM C1602 in order to ensure its quality meets standardized limits.

Targeted Constituents
- Suspended Solids
- Dissolved Solids – Metals
- Petroleum Hydrocarbons
- pH Changes

Estimated Costs
- High Capital $$$
- Moderate Capital $$
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $$
- Low Maintenance $
Stormwater Utilization

Advantages

- **Water Conservation/Costs.** Using stormwater from retention areas reduces or eliminates purchased water and reduces pumping costs from deep water wells. The use of stormwater also reduces drawdown from groundwater aquifers and/or conserves water treated for human consumption.

- **Stormwater Run-Off Compliance.** Sediments and other materials transported by stormwater should not be discharged from areas where stormwater is collected for use. Stormwater from process water areas should be collected in basins or other containment structures. In some cases, all stormwater from the entire facility can be collected and never discharged, virtually eliminating liabilities associated with the discharge of stormwater.

- **Reduces the Potential Off-Site Discharges of Comingled Water.** Containing stormwater for subsequent use it may also help reduce the potential for the discharge of stormwater that has cominged with process water.

- **Passive System.** While the actual use of stormwater is not a passive operation, collection of stormwater for use typically is. If properly designed, the collection of stormwater for subsequent use can occur passively through rainy cycles and seasons – continuous human oversight may not be needed.

- **Low Maintenance.** Depending on the containment system used, the maintenance of a stormwater collection system can be low. Pumps and piping will need to be periodically maintained. Sediment from the containment system may need to be periodically removed.

Limitations

- **Capital Costs.** Containment structures to collect and store stormwater for subsequent use can be expensive to construct. These structures may include concrete lined pond(s), earthen pond(s), and/or tank(s), etc. All structures require capital expenditure and these costs may be substantial. Costs will vary depending on the size of a facility, annual rainfall, and whether it is a new or existing facility.
Stormwater Utilization

- **Potential Groundwater Impacts.** Stormwater may contain constituents that represent a threat to groundwater. If the collection and storage structures are not lined, analyses may be required to ensure that the potential for impacts to groundwater are negligible.

- **Size and Siting Requirements.** The size of the system used for the collection of stormwater can be relatively large and many facilities may not have adequate space available. Existing facilities may not be properly graded to enable collection at an available location of the facility. Re-grading could involve removing concrete, asphalt, and possible temporary removal of the plant itself. An engineered evaluation is needed in order to ensure that the containment structure is properly sized for area of the facility that drains into it. The square footage of the stormwater runoff area, periodic rainfall maxima, and the porosity of the area draining to the collection system all require evaluation by an experienced professional. The evaluation must consider the fact that minimal water will be used by the plant during the “wet” season while stormwater is being accumulated in the containment structure(s).

- **Quality Control.** As mentioned above, the water should be analyzed by checking for any impurities that may adversely affect concrete quality in accordance with ASTM C1602.

**Uses/Engineering/Design**

- Stormwater may be used for various plant processes, including site dust control; washout, washdown, or rinsing activities; irrigation; etc.

- When evaluating the potential use of stormwater as a source of process water for concrete batch water, samples must be taken and analyzed to check for any impurities that may adversely affect concrete quality, in accordance with ASTM C1602.

- Impurities potentially present in stormwater that could diminish concrete quality must be corrected.

- In some cases, blending stormwater with municipal/well water may be an excellent option for use as concrete batch water. If treatment costs are high for use in concrete batching, it may be more cost
Stormwater Utilization

effective to use stormwater for haul road dust suppression or as a supply for truck wash/rinse activities, and restrict batching to municipal/well water. Producers should also consider the resources needed to use stormwater such as pumps, motors, piping, sumps, and fencing for stormwater retention areas. The facility operator should also consider what options should be taken during winter months of operations when pipes may freeze and stormwater use can be more difficult.

Implementation/Maintenance
See discussion on sampling and treatment above.

Cost
4.16 Training
Training

Applicability

☑ All Facilities
☐ New Facilities
☐ Facilities Undergoing Significant Renovation
☐ Facilities Undergoing Minor Site Improvements

Description

Proper training and education of employees is one of the most important aspects of the facility’s proper process water management.

It is important that each employee involved with process water management understands the management objectives and requirements and follows all relevant BMPs.

Targeted Constituents

⊕ Suspended Solids
⊕ Dissolved Solids – Metals
⊕ Petroleum Hydrocarbons
⊕ pH Changes

Estimated Costs

☐ High Capital $$$
☐ Moderate Capital $$
☑ Low Capital $
☐ High Maintenance $$$
☐ Moderate Maintenance $$
☑ Low Maintenance $
Training

Advantages

• Training minimizes environmental impacts, and satisfies regulatory requirements.
• Training enhances productivity.
• Training helps ensure regulatory compliance.
• Training helps control compliance and maintenance costs.

Limitations

• There are no limitations to effective and thorough training.

Uses/Engineering/Design

Training of employees should be conducted in a two-tier system and records of all training should be maintained and be readily available, according to permit requirements. The training log should include the type, time, location, training topics, and employees’ names.

• **Tier 1 Training** should be a comprehensive training that occurs when a new employee is hired. Tier 1 Training should be annually refreshed. This training should target managers and employees who actively manage and are responsible for the operation and maintenance of the process water management systems.

  o At a minimum, Tier 1 Training should include the following:

    • A general synopsis of Federal, State, and local regulatory requirements governing the management of process water and stormwater.

    • A general understanding of concrete process water, and its potential impacts to surface and ground water.

    • A site-specific understanding of the process water and storm water areas of the site.

    • An understanding of the BMPs that have been chosen and implemented, and respective objectives of these BMPs.

    • An understanding of the choice of other potential BMPs that may be required in order to adapt to changing operational, site, environmental, or climatic conditions.
Training

- An understanding of inspection and maintenance requirements.
- An understanding permit requirements.
- An understanding of emergency-response procedures.

**Tier 2 Training** should target ready mix concrete truck drivers and plant/fleet maintenance personnel who conduct operational activities at the site, but are not responsible for the operation and maintenance of the process water and storm water management systems. Tier 2 training should be conducted for all employees new to a particular plant or facility and be refreshed on an annual basis.

  o At a minimum, Tier 2 training should include the following:
    - A general understanding of the descriptions of and differences between process water and storm water.
    - A discussion of pond level characteristics such as the minimum required free board or maximum water height, and whom to contact if these levels are approached.
    - Instruction regarding the beneficial effect of water conservation, and the detrimental effects of water overuse.
    - Instruction on the use of piping and water control shut off valves.
    - What to do if any out-of-compliance situation is observed. An understanding of emergency-response procedures.

**Implementation/Maintenance**

The training should be implemented in accordance with company policy and all documents and training records must be retained in accordance with the facilities permit.

**Cost**

- Training costs are usually limited to the costs of preparing materials, and to the straight-time and over-time wages.
4.17 Water Balance Evaluation
## Water Balance Evaluation

### Description
A water balance evaluation is a critical engineering tool that should be conducted either prior to or in parallel with all site operational engineering evaluations.

The purpose of a water balance evaluation is 1) to predict maximum flows of water from all sources to process water containment/storage structures; 2) to provide data for design considerations of process water containment/storage structures; and 4) to provide data for further evaluation of additional BMPs for minimizing process water flows.

A water balance evaluation is therefore highly site-specific and considerable knowledge about the site layout, facility operations, and regional climate is required for an accurate assessment.

### Applicability
- [x] All Facilities
- [ ] New Facilities
- [ ] Facilities Undergoing Significant Renovation
- [ ] Facilities Undergoing Minor Site Improvements

### Targeted Constituents
- 🔷 Suspended Solids
- 🔷 Dissolved Solids – Metals
- 🔷 Petroleum Hydrocarbons
- 🔷 pH Changes

### Estimated Costs
- High Capital $$$
- Moderate Capital $
- Low Capital $
- High Maintenance $$$
- Moderate Maintenance $
- Low Maintenance $
- No Maintenance
Advantages

- **Predictive Design Tool.**
  - A water balance evaluation is predictive of flows of water into process water collection and storage systems, and is therefore a useful tool for design of the maximum required volume of such systems. The design of process water containment and storage systems which fails to account for rainwater falling on process water runoff areas is likely to result in systems that are undersized, and unintentional release of stormwater with unacceptable levels of potential pollutants is possible.
  - A water balance evaluation is also predictive of flows of water from rainfall on non-process water runoff areas. Stormwater runoff from these low-impact areas of a site may require treatment for TDS, TSS, or pH changes prior to discharge. Data from a water balance evaluation will facilitate the subsequent design of passive or active stormwater runoff treatment measures. Note that a water balance evaluation for non-process water runoff areas is not part of the scope of this BMP, but is a logical and easy extension of this evaluation.

- **Process Enhancement.** A water balance evaluation provides data regarding the amount of process water generated by various process activities. These data can then be used to refine the process activities, minimizing process water generation and maximizing process water utilization. Examples follow:
  - Truck Rinsing. In some ready mix facilities, trucks need to be rinsed following loading. The use of a large hose with relatively high flowrates makes rinsing a quick process, however these hoses can deliver in excess of 50 gallons per minute. If the driver rinses the truck for two minutes using one of these hoses, then a 1,000 cubic yard production cycle can add nearly 10,000 gallons of process water per day to the process water system. Conversely, by using high-pressure, low-flowrate pressure washers, the amount of process water generated can be reduced by greater than 90 percent.
Water Balance Evaluation

- **Plant Washdown.** The loadout area (the area where either the individual concrete constituents or the pre-mixed concrete is loaded into the ready mix delivery truck) is the area where pre-mixed concrete or concrete constituents may splash. Under the certain operating conditions, a plant operator may need to clean the loadout area several times per day. Using the same large hoses and flow rates cited above, six 10-minute plant washdown events will generate 3,000 gallons of process water. Conversely, by using clarified process water from the weired process water basins (if installed) for the plant washdown, no additional process water is added to the process water system.

**Limitations**

- There are no drawbacks to performing a water balance evaluation, other than the cost of the time spent by a qualified person in performing the evaluation.
- **Garbage In/Garbage Out.** In the absence of accurate data regarding plant operations, the evaluation has the potential to produce inaccurate results.

**Uses/Engineering/Design**

See below

**Data Collection**

- **Operational Data Collection.** To perform an accurate water balance evaluation, a substantial amount of operational data is required. The following provides brief descriptions of some of the data requirements:

  - **Design/Actual Throughput.** “Throughput” refers to the amount of concrete batched. Most ready mix facilities are engineered with a “design throughput” – which refers to the likely maximum amount of concrete that will be batched in any given period. For existing facilities, historical data are typically reliable for providing the maximum throughput that a facility will likely produce. **Daily maxima and averages, annual maxima and averages, and seasonal variation** are the types of throughput
data needed for the completion of an accurate water balance evaluation.

- **Process-Water-Runoff-Area Footprint.** The process-water-runoff-area footprint is the area of the facility in which facility processes and/or operational activities are likely to contribute significant loads of potential pollutants to water (whether that water is originally sourced from municipal supply/well or stormwater runoff within the process water footprint). Ideally, the process water runoff area is segregated from other areas of the facility – as is further described in BMP XX-XX. The square footage (surface area) of the process water runoff area is calculated from design drawings or from physical measurements.

- **Percentage of Jobs Requiring Potable Water.** Some concrete orders require that only municipal supply/well water be used in the manufacture of ready mix concrete. These orders are typically for projects with extremely tight constraints on the ready mix concrete constituents or on the characteristics of the finished product. Such projects typically comprise a small percentage of any given facility’s throughput. If, however, the facility does manufacture significant amounts of this type of ready mix concrete, process water reuse will be affected.

- **Water In Batch.** The amount of water used as a constituent is the manufacture of ready mix concrete must be evaluated. These data can be sourced from mix design criteria or from historical data. If the data are sourced from mix design criteria, then the amount of mix design water contained within the entrained moisture of the aggregates (particularly the fine aggregates) must be subtracted from the mix design criteria. If the data are sourced from historical data, then the most reliable source of these data are the batch panel databases for batches previously produced.

- **Process Water Generated During Plant Processes.** The water falling on to the ground within the process water runoff area during various plant processes contributes significantly to volume of water that must ultimately be collected and contained. This water comes primarily from the following activities:
Water Balance Evaluation

- **Truck Rinsing.** Ready mix concrete and/or concrete constituents that are splashed on to the ready mix truck during the loading process need to be rinsed from the truck following loading. Likewise, truck returning from delivery may need to rinse the gathering hopper and chutes prior to receiving another load or prior to parking the truck at the end of the business day. Truck rinsing can occur via a spray bar as the ready mix truck exits the loadout area, or via hose or pressure-washer rinsing at some location within the process water runoff area. An estimate of the average amount of water used during this activity is best determined using measurements of flowrate and time required for the rinsing.

- **Truck Washout.** Ready mix trucks typically require washout of the mixer drum one or more times throughout the day. The amount of water used and generated during this activity is substantial and can total greater than 300 gallons per event. If reclaimed process water is used for this activity, the net amount of water contributed to process water collection and storage systems is zero. Conversely, if municipal supply/well water is used for this activity, significant additional load is placed on the process water collection and storage systems. An estimate of the average amount of water used during this activity is best determined using measurements of flowrate and time required for the activity.

- **Plant Washdown.** As described in the example above, a facility operator may need to clean the loadout area several times per day. While shovels and brooms are a necessary part of this cleaning, high-flowrate hoses are likely also to be used, generating substantial volumes of additional process water if the water is sourced from municipal supply/well. Again, an estimate of the average amount of water used during this activity is best determined using measurements of flowrate and time required for the activity.

- **Heated Water.** In colder climates or in colder seasons, some ready mix concrete facilities batch with heated water, to partially offset the negative effect that lower temperatures have on
concrete set time. The heat exchangers in conventional boilers and water heaters are easily fouled if process water is introduced; these devices for heating water typically require the use of municipal supply/well water. For ready mix concrete facilities manufacturing significant amounts of product with heated water, process water reuse will be affected.

- **Average Load Size.** While the amount of water used as a constituent in the manufacture of ready mix concrete can be calculated as a constant (based on historical data or mix-design data), the amount of water used in other facility processes is variable depending upon such things as the load size and truck capacity. In other words, the amount of process water generated by such activities as truck rinsing, truck washout, and plant washdown will increase as the number of loads being batched increases. Therefore, if for a given production amount the average load size is small, more trucks will cycle through the facility – each needing to be rinsed after batching and washed down after delivery – thus producing more process water.

- **Facility-Closed Criterion – Rainfall-Based.** This is a somewhat subjective determination of the amount of rainfall likely to result in ready mix facility closure. If the facility is closed, no process water is being reused in batch processes, and the amount of process water in storage is likely to increase (as a result of rainfall on process water runoff areas). Historical data are particularly valuable for this evaluation – e.g., if a correlation between historical rainfall data and facility closure can be established, then this correlation can be used in the water balance evaluation. During these periods of weather-related closure, no process water is being reused in facility processes, and additional process water is likely to be generated because of rainfall on process water runoff areas. These conditions will contribute to the ultimate size requirement for process water storage structures.

- **Plant-Closed Criteria – Calendar- and Throughput-Based.** These criteria are 1) an objective assessment of the days the plant will be closed due to weekends and holidays, and 2) a subjective assessment of the days a plant will be closed due to lack of
Water Balance Evaluation

business, respectively. Again, if stormwater runoff contributes to the volumes stored in process water structures on days the facility is closed, the ultimate required size of these structures will increase.

- **Stormwater Runoff Diversion Criterion.** In many ready mix facilities, the character of stormwater runoff within process areas is pristine, after the first flush of rainfall has washed the potential pollutants into the process water system. Diversion of additional stormwater runoff – if 1) large rainfall amounts are predicted, 2) several days of rainfall are predicted, and 3) the plant remains closed – may be a reasonable Best Management Practice to limit to potential for process water structures to overfill and overflow.

- **Maximum-Rainfall-Event Process Water Storage Criterion.** Some jurisdictions require complete capture, containment, and storage of all stormwater falling within a process water area. Others require that the process water structures be capable of containing the runoff from a 100-year storm event. The storage criterion will determine the ultimate required size of the collection, containment, and storage structures.

- **Climatic Data Collection.** To perform an accurate water balance evaluation, climatic data are required.

  - **Daily Precipitation Data.** The daily precipitation data for the ‘Maximum-Rainfall-Event Process Water Storage Criterion’ must be sourced. For example, if the regulatory agency determines that the facility must be able to maintain collection and storage of process water for a 100-year storm event, then the available data must be researched to source the location-specific daily rainfall data for the recent 100-year storm event. It is recommended that the daily rainfall data for the entire water year encompassing the historical 100-year storm event be sourced, as these data will be valuable in the preparing the comprehensive water balance evaluation.

Evaluation Overview

- **Concepts.** The following concepts are used in a water balance evaluation.
Water Balance Evaluation

- **The System.** The process water runoff area and the facility processes conducted within the area are viewed as a system. All water entering and exiting the system, regardless of the source or disposition, needs to be considered.

- **Influent Water.** All water entering the system – from municipal supply, from well, or from stormwater runoff – is called influent water.

- **Effluent Water.** All water exiting the system – as a permanent part of ready mix concrete or as a sanitary sewer discharge – is called effluent water. – Also evaporation and infiltration.

- **Recycled Water.** Water that is removed from the process water collection and storage system, is used in a plant process, and is then returned to the process water collection and storage process is called recycled water. An example of recycled water is the water used for truck washout. If the water is pumped out of the weired process water basins into the ready mix drum and then discharged back into the weired process water basin, the volume of water used has minimal impact on the overall process water storage system size requirement.

Note that minimum process water collection and storage requirements may be operationally driven – as opposed to being driven by environmental protection considerations. A facility operator may choose to maintain a minimum volume of process water for truck drum washout, for plant washdown, or for weired process water basin function.

- **The Balance.** If over any given period of time the volume of effluent water remains less than the volume of influent water, then the size of the process water collection and storage system must make up the balance.

By way of illustration, during a typical warm, dry summer week, the ready mix facility will likely manufacture a peak volume of ready mix concrete. Each cubic yard of concrete manufactured represents a potential opportunity to permanently remove over 20 gallons of process water from the system. During such periods, the amount of water required for ready mix production may
Water Balance Evaluation

exceed the process water available within the process water collection and storage systems. These systems need only be sized to manage daily influent/effluent inequalities and treatment of process water for reuse.

Conversely, during a cool, wet, mid-winter week that starts or ends with a holiday, the volume of influent water to the system from plant processes and more significantly from stormwater falling within the process water runoff area will likely far exceed the effluent water leaving as a permanent part of the ready mix concrete. The process water collection and storage system must be sized to handle the excess influent water. As the cool, wet, slow weeks compound, the process water storage demand further increases.

- **Evaluation Procedure.**
  - **Modeling vs. Equation.** The water balance evaluation is a mathematical evaluation, but it is too complex to be reduced to an equation. It is therefore an application of modeling.
    - **Defined Inputs.** Defined inputs are the data that are determined in advance to be governing data sets, and include such data groups as periodic throughput data and periodic climatic data.
    - **Variables.** Other inputs are data that can be manipulated, and as such are variables. By manipulating these variables, the effects of process enhancements on process water storage requirements can be immediately illustrated. In a previously stated example, changing the method used for truck rinsing (from a low-capital-investment hose to a higher-capital-investment pressure washer) can result in a 90 percent reduction of process water generation for this operational process. Likewise, minimizing the process water footprint area or maximizing the use of process water used in plant washdown will also facilitate process water management. These ‘variable variables’ can be adjusted in infinite combinations to fit operational and process-water-management objectives.
Data, Iterations, and Spreadsheets. Because of the large number of defined input data points, including daily throughput values and daily climatic values, and because of the number of variable configurations – which are iterations of the same evaluation – this modeling far exceeds that which can be accomplished with pencil and paper. A spreadsheet evaluation is recommended.

Spreadsheet Evaluation Outline

The following outline suggests a method for crafting a spreadsheet for the modeling of a ready mix facility water balance. This outline is for guidance only – design of the actual tool with site-specific considerations is left to the facility operator and his/her design or consultation team.

(1) Enter Assumptions

(a) design throughput, annual
(b) proportion of all jobs that are potable/well water only
(c) average load size
(d) plant closed if rainfall exceeds: ____inches
(e) divert runoff if rainfall exceeds: ____inches
(f) process water runoff area stormwater retention criterion
(g) minimum storage capacity (for operational purposes)
(h) average water in batch, per cubic yard
(i) average water into truck water tanks, per cubic yard
(j) average water added to drum at slump rack, per cubic yard
(k) average water used at rinse area, per truck per load
(l) average water used in truck washout
(m) percentage of truck washout water that is recycled i.e., sourced from and returned to process water basin
(n) water used in plant washdown & frequency
(o) percentage of truck washout water that is recycled i.e., sourced from and returned to process water basin

(2) Fixed Data Setup – in successive columns:
(a) date – recommend July through June (water year)
(b) logical argument for Sat & Sun
(c) logical argument for holidays
(d) daily rainfall data for year of record
(e) plant “open” or “closed” determination based on (b), (c), (d)

(3) Throughput Evaluation – in successive columns:
(a) average daily throughput for “open” days
(b) seasonal adjustment to daily throughput
(c) randomized daily adjustments within 2 to 3 SDs
(d) resulting randomized daily throughput

(4) Effluent (Process Water) Demand
(a) in concrete manufacture
(b) at slump rack
(c) maximum possible reclaimed water use

(5) Influent Potable/Well Water Demand
(a) truck tank filling
(b) truck rinse systems
(c) required fresh water makeup batch demand
(d) daily truck count at average load size

(6) Process Water Basin/Storage System Volume
(a) start of day volume
(b) effluent water used in batch process
(c) influent water reclaimed from truck rinsing
(d) influent water reclaimed from plant washdown
Water Balance Evaluation

(e) recycled water used in plant washdown
(f) influent water from rainfall in process water runoff area
(g) water diverted from system from runoff
(h) effluent water discharged to sanitary, if permitted
(i) end of day sump volume

The end-of-day sump volume is predictive of the maximum volume likely necessary for environmentally responsible management of process water.

Cost

- **In-House Engineering or Consultant Fees.** The costs for completing an accurate water balance evaluation are very low. For proposed and for existing facilities, site-specific measurements and assessments, design of the evaluation (spreadsheet), and iterative evaluation of the facility’s alternatives (variables) for process water management should require less than ten working days. The money saved in managing excess process water for just one wet weather season should easily exceed the costs of this technical evaluation.
Example

A basin analysis is presented below, and the results of a water balance evaluation are presented on the following page.

**Required Basin Size as a Function of Water Used at Washrack**
Analysis: Water Balance Evaluation

Use "Ctrl" + "Shift" + "R" to randomize the evaluation. Be sure the "Caps Lock" is off.

design throughput: 120,000 yd³
fresh-water only: 10 %

randomized throughput: 122,320 yd³
non-fresh-water only: 90 %
average load size: 9.0 yd³
number of loads: 13,333

closed if rain is > 0.50 in.
divert H₂O if rain is > 0.75 in.
% of El Niño water year: 100 %

process water area: 12,000 ft²

water used in batch: 22 gal per yd³ -- assumes maximum use of reclaimed water
water used in truck tanks: 1.0 gal per yd³ -- assumes fresh water only
water at slump racks: 1.0 gal per yd³ -- fresh water
0.0 gal per yd³ -- reclaimed water

water used in drum rinse: 0 gallons of fresh water per rinse
300 gallons of reclaimed water per rinse
truck drum rinsed every: 3 loads

water utilized at washrack: washdown will use 3 gal per min
for 5 minutes
every 1 loads

water utilized in plant washdown: washdown will use 50 gal per min
for 10 minutes
every 300 yards

seasonal throughput decrease, November and March: 20 percent
seasonal throughput decrease, December through February: 50 percent

minimum basin content for operational needs:
maximum basin volume needed under these conditions: 10,000 gal
40,208 gal

Key
operational, user-defined values
operational, calculated values
fresh water, user defined value
fresh water, calculated value
recycled water, if available, user-defined value
recycled water, calculated value
stormwater runoff, calculated value

Note: Analysis based on the 07/01/97 through 06/30/1998 El Niño Water Year
4.18 Weired Process Water Basin
**Weired Process Water Basins**

### Applicability

- ☑ All Facilities
- ☑ New Facilities
- ☑ Facilities Undergoing Significant Renovation
- ☐ Facilities Undergoing Minor Site Improvements

### Description

A weired process water basin system consists of a series of concrete lined settlement basins designed to collect and treat process water from truck and plant processes, allowing for process water reuse. The weired process water basin directs the water through a series of sequential chambers, separated by weirs. The decant over the weirs, the reduced flow velocity, and the increased travel distance allows suspended solids to drop out of the water column to the bottom of each weir basin, where they can be removed via regular cleaning using front end loader. The water collected in the final weir basin can then be pumped directly back to the plant for immediate reuse or transferred into either in-ground or above-ground storage tanks for later use.

### Targeted Constituents

| + Suspended Solids |
| ☇ Dissolved Solids – Metals |
| + Petroleum Hydrocarbons |
| ☇ pH Changes |

### Estimated Costs

- ☑ High Capital $$$
- ☑ Moderate Capital $$
- ☐ Low Capital $
- ☐ High Maintenance $$$
- ☑ Moderate Maintenance $$
Advantages

- **Semi Passive System.** A weired process water basin system is a semi-passive treatment method to allow for the reuse of excess process water. If properly designed and maintained, the system will collect and treat excess process water with only periodic human oversight.

- **Simple Treatment Process.** A weired process water basin can be designed with no moving parts, although most systems utilize one or more pumps. The main operational forces that drive the system are gravity and time.

- **Moderate Maintenance.** If properly designed, a weired process water basin requires only periodic maintenance. The first sequential weir basin should be cleaned of accumulated sediment on a daily basis, usually prior to plant start-up. This allows for additional settling time during the non-operation hours of the day. The remaining weir basins will require less frequent cleaning. A site specific cleaning schedule should be determined to optimize operating efficiently.

- **Amenable to Customization.** The basic weir basin design can be easily adapted to site-specific conditions or issues. This can be achieved by increasing, or decreasing, the number of weir basins or by the addition of one or several optional components. Examples of add on components are:
  
  - Integral Wash-Out Concrete Pad. An integrated wash out pad adjacent to the first weir basin sloped so that all water placed on the wash out pad will flow to the first weir. This allows mixer drums to be rinsed with recycled water taken from the last weir and returned to the first weir. This increases wash out efficiency as long as consideration is given to the following: all possible concrete solids must be removed from the drum prior to wash out, the area of the wash out pad must be included in the process water runoff area. (See Engineering, below.)
  
  - Inter-weir Filtration. A number of highly efficient, in-channel, filtration products are now available on the market. These are sometimes referred to as “bristle or brush” filters and can be fitted
into the inter-basin weir openings to increase physical filtration during treatment of the excess process water. These filters can either be incorporated into the original design, or retrofitted into existing systems.

- Flocculation. To increase the settlement of fine particulate matter, various flocculent chemicals can be introduced into the system. This can be achieved by metered liquid chemical injection, manual broadcasting of dry powder on the water surface or suspending flocculent gel “logs” in the inter-basin weir openings.

- pH Adjustment. If it is necessary to adjust the finish water pH for reuse or disposal (for example, discharge to a sanitary sewer or POTW) a pH adjustment circuit can be added to treat, all or a portion of, the finish water leaving the system. This can be achieved by either acid injection or a CO₂ bubbler system. In either case, consideration must be given to proper mixing technologies and precipitate disposal.

- Finish Water Storage. It is often the case, particularly during wet weather and times of fluctuating customer demand, that more finish water is generated that can be immediately used by plant operations. This is exacerbated when it was not possible to minimize the process water runoff area during initial design. To remedy this issue, finish water storage can be added either as part of the initial design, or retrofitted to improve an existing system.

Limitations

- **Capital Costs.** A weired process water basin system is expensive to construct. In addition, if siting restrictions result in unfavorable placement, additional costs will be incurred from the construction and installation of swales, ditches, piping and pumps. These additional equipment and structures will also increase operation and maintenance costs over the life of the basin system.

- **Wet Weather Limitations.** During wet weather, rain fall within the process water runoff area will be captured by the weired process water basin system. If insufficient storage is provided, or the area of process water runoff is excessive, the basin system can be inundated and overtopped.
Uses/Engineering/Design

- When engineering a weired process water basin system, several aspects of the design must be considered.
  
  o Sizing. An engineered evaluation is needed in order to ensure that the basin is properly sized for the area of the facility that drains into it. (See BMP WM-01) The square footage of the process water runoff area, periodic rainfall maxima, the proximity of the collection area to the basins and the traffic patterns within the plant all require careful study and evaluation by an experienced professional.

  o Minimal Structural Concerns. Site soil conditions must be taken into account when designing the concrete lining for the weired process water basin. Structural integrity must be maintained under maximum loads expected from front end loader and mixer truck traffic. Suggested reinforcing drawings are presented in Appendix XX. However, it must be stressed that these are offered as suggestions and will not replace site-specific design.

  o Flow. Gravity flow to the weired process water basins has been shown to be the preferred mode of transport of excess process water, whether via concrete swales or grated ditches. However, particularly during retrofit installations, it may be necessary to pump the excess process water to the basin. (See Siting Considerations below.)

  o Ease of Cleanout. Thought should be given to ease of basin cleanout and the equipment used. Depth and width of the basins should be fitted to the front end loader used for cleanout.
    
    ▪ The depth of the wetted surface in each basin should never be greater than the center line of the wheel radius of the loader to be used for basin cleanout. Greater basin depths will result in increased maintenance and possible damage to the loader.
    
    ▪ The width of each basin should be kept to a minimum to allow loader access. Usually the basin should be about one foot greater in width than the width of the loader bucket. This greatly reduces the amount of water and sediment that will be flushed around the loader bucket during cleanout.
When laying out the placement of the basin system one should consider the front end loader access for basin cleanout and the path of the loader to the storage area where the removed sediment will be placed.

**Siting Considerations.** In general, the key to success of a weired process water basin system is to keep the area of excess process water generation, and therefore, collection to a minimum. To achieve this, it is best to site the basin system imminently adjacent to the plant with all appurtenant excess process water generating processes in close proximity (slump racks, wash out stands, etc.) This is best accomplished at new facilities where the basin system can be engineered into the preconstruction design. However, when a weired process water basin system is retrofitted into an existing facility, the current site configuration grading and underground utilities may require that the basin system is placed some distance from the plant and other excess process water generating operations. This often results in additional process water runoff area that must be considered when designing for rainfall maxima and finish water storage. Likewise, means of conveyance to the basin from the other areas of the facility need to be considered – whether via overland flow through swales, or through pipes or trenches.

**Space Requirements.** The base area for a simple four chambered weired process water basin system is about 50 by 50 feet. However, the addition of sloped aprons, feeder swales, adjacent slump and wash out racks can increase this minimal area several fold.

**Implementation/Maintenance**

- A properly engineered weired process water basin requires only periodic maintenance.

- The first sequential weir basin should be cleaned of accumulated sediment on a daily basis, usually prior to plant start-up. This allows for additional settling time during the non-operation hours of the day.

- The remaining weir basins will require less frequent cleaning.
A site specific cleaning schedule should be determined to optimize operating efficiently.

Cost

- **Capital Costs.** The design and installation of weired process water basins is high, commonly exceeding $150,000 for a basic system. Because of the high capital cost it is most appropriate for new facilities and facilities undergoing major renovation. Cost savings can be realized with the design of a gravity flow system in close proximity to the batch plant. This reduces pump installation costs and auxiliary concrete work.

- **Maintenance Costs.** Maintenance cost for weired process water basins moderate, consisting mostly of housekeeping and minor repairs. A design that relies on numerous pumps and piping runs will require substantially more maintenance than a simple gravity flow system.
APPENDIX 1

GLOSSARY
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-Year Storm</td>
<td>A storm intensity that has a 1-percent probability of occurring. For greater definition of the intensity of the storm, the duration of the storm needs to be specified, e.g., a 1-hour storm, or a 24-hour storm.</td>
</tr>
<tr>
<td>Adsorption</td>
<td>A process in which soluble substances are attracted to and held at the surface of soil or other particles.</td>
</tr>
<tr>
<td>Acidity &amp; Alkalinity</td>
<td>Relative terms for the amount of hydrogen cation ( (H^+) ) or hydroxyl anion ( (OH^-) ) present in an aqueous solution, respectively.</td>
</tr>
<tr>
<td>Aggregate, Coarse</td>
<td>Any of several types of gravel or rock. Coarse aggregate is typically retained on (does not pass through) a #4 sieve (0.187 inches).</td>
</tr>
<tr>
<td>Aggregate, Fine</td>
<td>Any of several types of sand that would pass a #4 sieve (0.187 inches).</td>
</tr>
<tr>
<td>Aquifer</td>
<td>A geologic formation or stratum that contains and is saturated with water.</td>
</tr>
<tr>
<td>Block Forms</td>
<td>Any of several types of forms used to cast blocks, rip-rap, K-rail, sound walls, parking lot curbs using returned concrete. These items are not engineered pre-cast concrete products.</td>
</tr>
<tr>
<td>Cementitious Material</td>
<td>Any of the various forms of Portland cement, various types of flyash, various types of ground granulated blast furnace slag, or various types of mineral powders.</td>
</tr>
<tr>
<td>Conductivity</td>
<td>The quality or capability of transmitting electricity; usually measured in aqueous solutions as electrical conductivity (EC). Increasing conductivity of water typically correlates with the increasing presence of dissolved solids, particularly cations and anions.</td>
</tr>
<tr>
<td>Fixation</td>
<td>Physical and/or chemical mechanisms in the soil that act to retain water pollutants, including adsorption, chemical precipitation, and ion exchange.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>-------------------------------</td>
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</tr>
<tr>
<td>Groundwater</td>
<td>The body of water that is retained in the saturated zone. Groundwater frequently moves by hydraulic gradient.</td>
</tr>
<tr>
<td>Groundwater Table</td>
<td>The free surface elevation of the groundwater; this level will rise and fall with additions or withdrawals.</td>
</tr>
<tr>
<td>Industrial Stormwater Discharge</td>
<td>The discharge from any conveyance that is used for collecting and conveying storm water and that is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant (reference Industrial Stormwater Permit).</td>
</tr>
<tr>
<td>Infiltration</td>
<td>The passage of water from above the soil surface into the vadose (unsaturated) zone of the subsurface.</td>
</tr>
<tr>
<td>Irrigation</td>
<td>The application of water to the land to meet the growth needs of plants.</td>
</tr>
<tr>
<td>Mineralization</td>
<td>The conversion of a compound from an organic form to an inorganic form as a result of microbial activity.</td>
</tr>
<tr>
<td>Permeability</td>
<td>The ability of a substance (soil) to allow passage of water.</td>
</tr>
<tr>
<td>Process Water Footprint</td>
<td>Consists of all plant area encompassing cementitious processes, including ready mix concrete batching and loadout, and the process water management system.</td>
</tr>
<tr>
<td>Process Water System</td>
<td>Consists of all infrastructure and equipment for the collection, storage, reuse, and possible treatment of Process Water. Process water systems infrastructure and equipment may include swales, ditches, culverts, pipes, basins, pumps, and tanks.</td>
</tr>
<tr>
<td>Throughput</td>
<td>A term frequently used in the ready mix concrete industry to describe the volume of concrete manufactured over any given period of time, e.g., 180 cubic yards per hour. Some regulatory agencies use the term “throughput” to also describe the mass of any given material utilized in plant processes over any given period of time, e.g., 875 tons of coarse aggregate per day.</td>
</tr>
<tr>
<td>Water, Effluent</td>
<td>Water that exits the process water system of a facility, whether as a permanent part of the ready mix concrete matrix, as a sanitary sewer discharge, or as evaporation.</td>
</tr>
</tbody>
</table>
Water, Influent  Water that enters the process water system of a facility, whether from municipal supply, well, or stormwater runon.

Water, Process  Any water that has come into contact with plant processes and/or cementitious materials. Please see also the definition for Industrial Stormwater.

Windrow  The practice of placing unused concrete into long, narrow piles. The windrows are easily broken up by a loader for beneficial reuse.

**Acronyms**

**BMP**  Best Management Practice, consisting of one or more of the following, which is (are) implemented to mitigate the potential for the contamination of stormwater: evaluations, infrastructure enhancements, process enhancements, or work patterns.

**LEED**  Leadership in Energy and Environmental Design, an internationally recognized green building certification system.

**mg/l**  milligrams per liter. This is a typical measurement of potential pollutant concentration in water. One milligram is the mass of one-millionth of a liter of water, so this measurement is sometimes referred to as parts per million.

**mmho/cm**  millimhos per centimeter. These units are commonly used to report the electrical conductivity of a sample of water.

**pH**  A measure of the absolute concentration of hydrogen ion ($H^+$) in water. pH is the negative of the base 10 logarithm of the hydrogen ion concentration in moles per liter.

**PM**  Particulate Matter

**POTW**  Publicly Operated Treatment Works

**SWPPP**  Stormwater Pollution Prevention Plan

**TDS**  Total Dissolved Solids. This is a measure of pollutants that are soluble in water. Dissolved solids may include metal and non-metal ions and certain types of organic compounds.
TOC  Total Organic Carbon. This is a measure of organic pollutants that are varyingly soluble in water. The measurement may also include immiscible organic compounds floating on the surface of the water.

TSS  Total Suspended Solids. This is a measure of pollutants that are not soluble in water, and may remain suspended in water. Suspended solids include fine particles of aggregate and cementitious material.

µg/l  micrograms per liter. This is a typical measurement of potential pollutant concentration in water. One microgram is the mass of one-billionth of a liter of water, so this measurement is sometimes referred to as parts per billion.
APPENDIX 2

WATER BALANCE EVALUATION
APPENDIX 3

ARTICLE “RECYCLED WATER IN READY MIX CONCRETE OPERATIONS”
APPENDIX 4

ARTICLE “RETENTION OF READY MIX PROCESS WATER”
APPENDIX 5

ARTICLE “RESULTS OF CONCRETE WASHWATER AND SAMPLING AND ANALYSIS”
APPENDIX 6

ARTICLE “PROTOTYPICAL RETENTION SUMP DESIGN”
APPENDIX 7

REGULATORY HISTORY
APPENDIX 8

REGULATORY FRAMEWORK