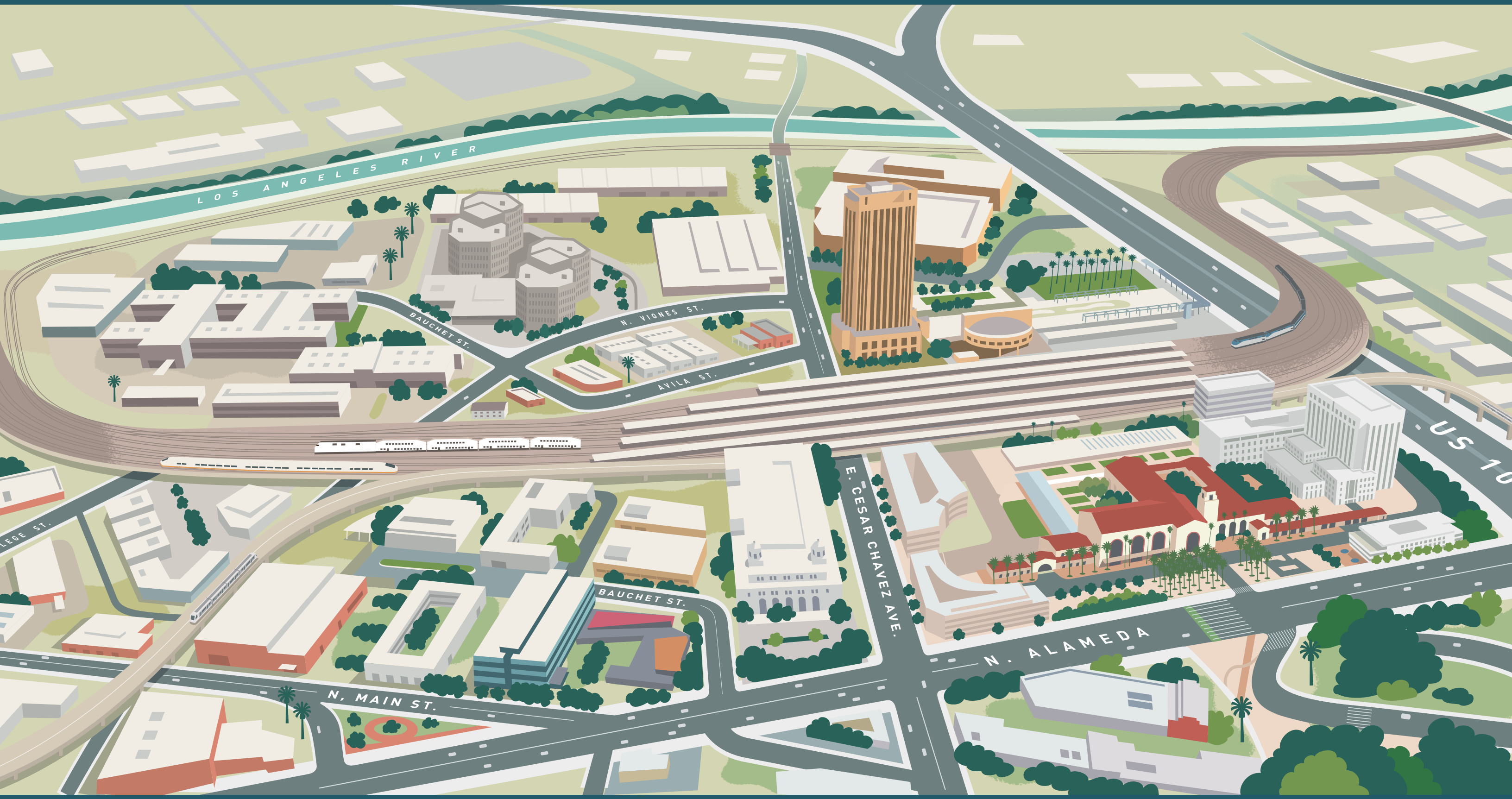
Los Angeles County
Metropolitan Transportation Authority

Link Union Station

Preliminary Low Impact Development Report

June 2019



Metro

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ACRONYMS

BMP	best management practice
Caltrans	California Department of Transportation
HSR	High-Speed Rail
LAUS	Los Angeles Union Station
LID	low impact development
Link US	Link Union Station
Metro	Los Angeles County Metropolitan Transportation Authority
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollution Discharge Elimination System
POC	pollutants of concern
RCP	reinforced concrete pipe
ROW	right-of-way
TMDL	total maximum daily load
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet

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ES.0 Executive Summary

This Preliminary Low Impact Development (LID) Report serves as the preliminary LID plan for the Link Union Station project (project). The preliminary LID plan applies to portions of the project that would occur outside of the jurisdiction of the California Department of Transportation's (Caltrans) National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, which applies to the right-of-way (ROW) for US-101. The project would be designed to be consistent with City of Los Angeles LID Ordinance No. 183833 (LID Ordinance). The LID Ordinance is consistent with Los Angeles County NPDES MS4 Permit Order No. R4-2012-0175. Consequently, City of Los Angeles Section 2.4 of the *Planning and Land Development Handbook for Low Impact Development* (LID Manual) states that agencies such as the Los Angeles County Metropolitan Transportation Authority (Metro) must prepare an LID Plan for non-roadway transportation projects, rail lines, and stations and implement stormwater mitigation measures.

This Preliminary LID Report was prepared to:

- Identify stormwater pollutants of concern (POC) in the project study area (non-Caltrans ROW) that address the post-construction phase
- Conduct preliminary stormwater quality calculations
- Recommend a conceptual best management practice (BMP) approach for the post-construction phase

This report includes an analysis of existing and proposed drainage systems and stormwater management BMPs utilizing the area encompassing the maximum extent of physical disturbance associated with the proposed project (project footprint). Although this report reflects the quantities and exhibits associated with the proposed project, project-related drainage outside of Caltrans ROW would be managed similarly for the build alternative because the respective tributary drainage subwatersheds and storm drain systems would be affected similarly. This drainage nexus extends similarly to the stormwater quality approach. Key assumptions and findings of this report are summarized below:

- One hundred percent imperviousness is assumed for elevated tracks on cellular concrete fill
- Tracks at-grade are assumed to be 15 percent imperviousness
- Reconstructed street improvements are assumed to be 91 percent imperviousness
- The total area within the project site is 110.90 acres, of which 70.44 acres (64 percent) is considered impervious surface in the existing condition
- For the proposed condition, 72.74 acres (66 percent) is considered to be impervious surface

In accordance with the LID Manual, the project falls under the "All Other Developments" category. The LID Manual specifies BMPs to be implemented in the following priority order: infiltration (Tier 1), capture and use (Tier 2), biofiltration/bioretention (Tier 3), or a combination of any of the above. Based on the *Link US Phase I Environmental Site Assessment* (HDR 2016a), the majority of the soil where physical disturbance would occur is contaminated and not suitable for infiltration (Tier 1). Therefore, unlined landscaping improvements, including irrigation, are not feasible for the project. Tier 2 (capture and use) and Tier 3 (bioretention) are viable approaches to meet LID requirements. To mitigate for stormwater quality impacts, the preferred conceptual BMP approach is proposed.

- In Segment 1: Throat Segment, a structural stormwater vault would address the area north of Vignes Street; a capture and use BMP (cistern) would address the rest of this segment, including a portion of the concourse area (Segment 2: Concourse Segment). For the build alternative, modification of local city streets (Bolero Lane, Bloom Street, and Leroy Street) would occur, and the drainage pattern will remain the same as the existing condition. Implementation of the City of Los Angeles Green Street Standards would be applied at this location, similar to the BMPs proposed in Segment 3: Run-Through Segment.
- In Segment 2: Concourse Segment, capture and use BMP (cisterns) are proposed. The extent of BMPs in the concourse area will be refined in final design. For the build alternative with an at-grade passenger concourse, the cistern concept will remain the same as the proposed project.
- In Segment 3: Run-Through Segment, south of US-101, bioretention BMPs are proposed for the proposed project and the build alternative. Bioretention BMPs would be applied on reconstructed public streets south of US-101 (i.e., Commercial Street, Center Street, and Ducommun Street). City of Los Angeles Green Street Standard Plans may be used and modified with bioretention features and impermeable liners to convey the underdrains to a nearby storm drain system. This approach would require concurrence from the City of Los Angeles. A structural BMP (Contech Jellyfish Filter) would address the area south of Ducommun Street where the tracks sit on the cellular concrete.

The following steps are recommended for further evaluation:

1. Conduct water demand analysis for capture and use cisterns. If after further analysis determines 100 percent of the water quality design volume cannot be managed through capture and use, the remaining volume is proposed to be managed through bioretention BMPs.
2. Conduct further exploration of other BMP options as the engineering design progresses.
3. Update this Preliminary LID Report after the selection of post-construction BMP designs and consideration of operations and maintenance costs for each BMP.

1.0 Introduction

Metro is proposing the Link Union Station Project to transform Los Angeles Union Station (LAUS) from a "stub-end tracks station" into a "run-through tracks station" with a new passenger concourse that would improve the efficiency of the station and accommodate future growth and transportation demands in the region.

1.1 Project Location and Project Study Area

LAUS is located at 800 Alameda Street in the City of Los Angeles, California. LAUS is bounded by US-101 to the south, Alameda Street to the west, Cesar Chavez Avenue to the north, and Vignes Street to the east. Figure 1-1 depicts the regional location and general vicinity of LAUS.

Figure 1-2 depicts the project study area, which encompasses the extent of environmental study associated with potential direct, indirect, and cumulative impacts from implementation of the project. The project study area includes three main segments (Segment 1: Throat Segment, Segment 2: Concourse Segment, and Segment 3: Run-Through Segment). The existing conditions within each segment are summarized north to south below.

- Segment 1: Throat Segment – This segment, known as the LAUS throat, includes the area north of the platforms, from Main Street at the north to Cesar Chavez Avenue at the south. In the throat segment, all arriving and departing trains traverse five lead tracks into and out of the rail yard, except for one location near the Vignes Street Bridge where the tracks reduce to four lead tracks. Currently, special track work consisting of multiple turnouts and double-slip switches are used in the throat to direct trains into and out of the appropriate assigned terminal platform tracks.
- Segment 2: Concourse Segment – This segment is between Cesar Chavez Avenue and US-101 and includes LAUS, the rail yard, the Garden Tracks (stub-end tracks where private train cars are currently stored, just north of the platforms and adjacent to the existing Gold Line aerial guideway), the East Portal building, the baggage handling building with aboveground parking areas and access roads, the ticketing/waiting halls, and the pedestrian passageway with connecting ramps and stairways below the rail yard.
- Segment 3: Run-Through Segment – This segment is south of LAUS and extends east/west from Alameda Street to the west bank of the Los Angeles River and north/south from Keller Yard to Control Point Olympic. This segment includes US-101, the Commercial Street/Ducommun Street corridor, Metro Red and Purple Lines Maintenance Yard (Division 20 Rail Yard), BNSF West Bank Yard, Keller Yard, the main line tracks on the west bank of the Los Angeles River, from Keller Yard to Control Point Olympic, and the "Amtrak Lead Track" connecting the main line tracks with Amtrak's Los Angeles Maintenance Facility. Businesses within the run-through segment are primarily industrial and manufacturing related.

The project study area has a dense street network ranging from major highways to local city streets. The roadways within the project study area include the El Monte Busway, US-101, Bolero Lane, Leroy Street, Bloom Street, Cesar Chavez Avenue, Commercial Street, Ducommun Street, Jackson Street, East Temple Street, Banning Street, First Street, Alameda Street, Garey Street, Vignes Street, Main Street, Aliso Street, Avila Street, Bauchet Street, and Center Street.

1.2 Proposed Project Overview

The proposed project components are summarized north to south below.

- Throat and Elevated Rail Yard – The proposed project includes subgrade and structural improvements in Segment 1 of the project study area (throat segment) to increase the elevation of the tracks leading to the rail yard. The proposed project includes the addition of one new lead track in the throat segment for a total of six lead tracks to facilitate enhanced operations for regional/intercity rail service providers (Metrolink/Amtrak) and accommodate the planned High-Speed Rail (HSR) system within a shared track alignment. Regional/intercity and HSR trains would share the two western lead tracks in the throat segment. The rail yard would be elevated approximately 15 feet. New passenger platforms with individualized canopies would be constructed on the elevated rail yard, with an underlying assumption that the platform infrastructure and associated vertical circulation elements (stairs, escalators, and elevators) would be modified at a later date to accommodate the planned HSR system. The existing railroad bridges in the throat segment at Vignes Street and Cesar Chavez Avenue would also be reconstructed. North of Control Point Chavez, the proposed project also includes safety improvements at the Main Street public at-grade crossing on the west bank of the Los Angeles River (medians, restriping, signals, and pedestrian and vehicular gate systems) to facilitate future implementation of a quiet zone by the City of Los Angeles.
- Above-Grade Passenger Concourse with New Expanded Passageway – The proposed project includes an above-grade passenger concourse with new expanded passageway in Segment 2 of the project study area (concourse segment). The above-grade passenger concourse with new expanded passageway would include space dedicated for passenger circulation, waiting areas, ancillary support functions (back-of-house uses, baggage handling, etc.), transit-serving retail, office/commercial uses, and open spaces and terraces. The new passenger concourse would create an opportunity for an outdoor, community-oriented space and enhance Americans with Disabilities Act accessibility at LAUS. The elevated portion of the above-grade passenger concourse would be located above the rail yard, approximately 90 feet above the existing grade with new plazas east and west of the elevated rail yard (East and West Plazas). The new expanded passageway would be located below the rail yard to provide additional passenger travel-path convenience and options. Amtrak ticketing and baggage check-in services would occur at two locations at the east and west ends of LAUS, and new carousels would be constructed within the new expanded passageway. The above-grade passenger concourse includes a canopy over the West Plaza up to 70 feet in height, with individual canopies that would extend up to 25 feet over each platform. New vertical circulation elements would also be constructed throughout the concourse to enhance passenger movements

throughout LAUS while meeting Americans with Disabilities Act and National Fire Protection Association platform egress code requirements.

- Run-Through Tracks – The proposed project includes up to 10 new run-through tracks (including a new loop track) south of LAUS in Segment 3 of the project study area (run-through segment). The run-through tracks would facilitate connections for regional/intercity rail trains and HSR trains from LAUS to the main line tracks on the west bank of the Los Angeles River. A "common" viaduct/deck over US-101 and embankment south of US-101, from Vignes Street to Center Street, would be constructed wide enough to support regional/intercity rail run-through service, and future run-through service for the planned HSR system.

The proposed project would also require modifications to US-101 and local streets (including potential street closures and geometric modifications); railroad signal, positive train control, and communications-related improvements; modifications to the Gold Line light rail platform and tracks; modifications to the main line tracks on the west bank of the Los Angeles River; modifications to Keller Yard and BNSF West Bank Yard (First Street Yard); modifications to the Amtrak lead track; new access roadways to the railroad ROW; additional ROW; new utilities; utility relocations, replacements, and abandonments; and new drainage facilities/water quality improvements.

1.3 Build Alternative Overview

The primary differences between the proposed project and the build alternative are related to the lead tracks north of LAUS and the new passenger concourse. Compared to the proposed project, the build alternative includes the following:

- Dedicated Lead Tracks North of LAUS – The build alternative includes reconstruction of the throat, with two new lead tracks that would be located outside of the existing railroad ROW, facilitating a dedicated track alignment, with a total of seven lead tracks. Reconfiguration of Bolero Lane and Leroy Street would also be required.
- At-Grade Passenger Concourse – The build alternative includes an at-grade passenger concourse below the rail yard.

All other infrastructure elements are similar to the proposed project. The components of the build alternative are described north to south below.

- Throat and Elevated Rail Yard – The build alternative accommodates future HSR trains on dedicated lead tracks in the throat segment. The build alternative includes the addition of two new lead tracks for a total of seven lead tracks in the throat segment (with future HSR trains and some express/intercity services using the two western dedicated lead tracks and most regional/intercity trains using the five eastern lead tracks). The rail yard would be elevated approximately 15 feet. New passenger platforms with a grand canopy covering the elevated rail yard would be constructed, with an underlying assumption that the platform infrastructure and associated vertical circulation elements (stairs, escalators, and elevators) would be modified at a later date to accommodate the planned HSR system. The existing railroad bridges in the throat segment at Vignes Street and Cesar Chavez Avenue would also be reconstructed under the build alternative. North of Control Point Chavez, the build alternative also includes safety improvements at the Main Street public at-grade crossing on the west bank of the Los Angeles River (medians, restriping, signals, and pedestrian and vehicular gate systems) to facilitate future implementation of a quiet zone by the City of Los Angeles.

- At-Grade Passenger Concourse – The build alternative includes a new at-grade passenger concourse that would include space dedicated for passenger circulation, waiting areas, ancillary support functions (back-of-house uses, baggage handling, etc.), transit-serving retail, office/commercial uses, and open spaces and terraces. The at-grade passenger concourse would also create an opportunity for an outdoor, community-oriented space and enhanced Americans with Disabilities Act accessibility. The at-grade passenger concourse would be constructed below the elevated rail yard. Amtrak ticketing and baggage check-in services would occur at a centralized location where new carousels would be constructed at the concourse level. The at-grade passenger concourse also includes new plazas east and west of the elevated rail yard (East and West Plazas), and a grand canopy that would extend up to 70 feet above the elevated rail yard and West Plaza. New vertical circulation elements would also be constructed throughout the concourse to enhance passenger movements throughout LAUS while meeting Americans with Disabilities Act and National Fire Protection Association platform egress code requirements.
- Run-Through Tracks – The build alternative includes up to 10 new run-through tracks (including a new loop track) in the run-through segment. All infrastructure south of LAUS is the same as described above for the proposed project.

The build alternative would also require modifications to US-101 and local streets (including potential street closures and geometric modifications); railroad signal, positive train control, and communications-related improvements; modifications to the Gold Line light rail platform and tracks; modifications to the main line tracks on the west bank of the Los Angeles River; modifications to Keller Yard and BNSF West Bank Yard (First Street Yard); modifications to the Amtrak lead track; new access roadways to the railroad ROW; additional ROW; new utilities; utility relocations, replacements, and abandonments; and new drainage facilities/water quality improvements.

Figure 1-1. Project Location and Regional Vicinity

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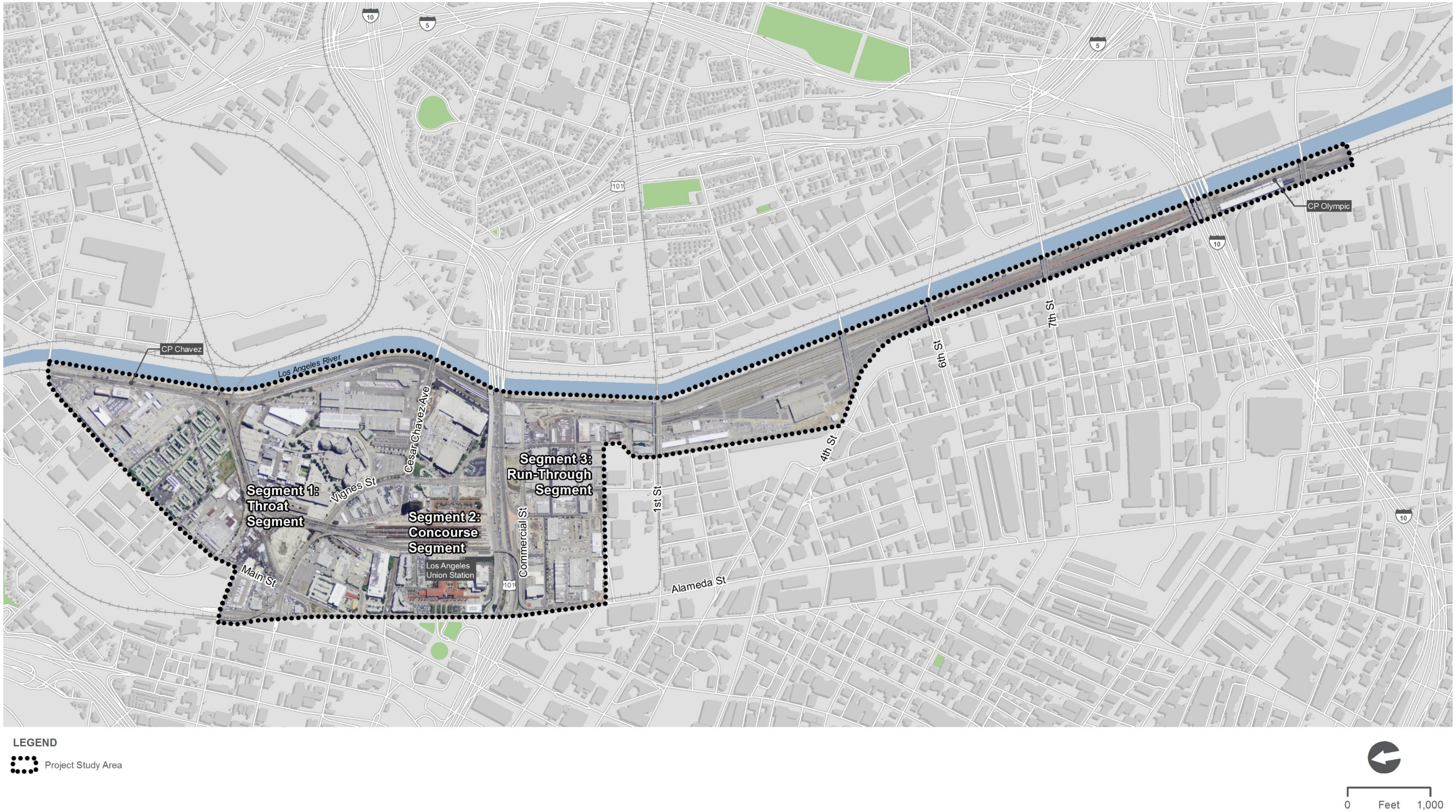
Figure 1-2. Link US – Project Study Area



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1.4 Purpose

This Preliminary LID Report was prepared to:

- Identify stormwater POC in the project study area (non-Caltrans ROW) that address the post-construction phase
- Conduct preliminary stormwater quality calculations
- Identify a preferred conceptual BMP approach for the post-construction phase
- Provide recommendations for further consideration in the final engineering phase

1.5 Approach

The following approach was taken during preparation of this Preliminary LID Report:

- Baseline Assumptions – Establish baseline assumptions and criteria to be used for this analysis.
- Agency Requirements – Provide an overview of agency standards, guidelines, and methodology to be used in this document.
- POC – Identify POC from the stormwater runoff tributary to the project site within the project study area that may contribute to the stormwater conveyance system.
- Stormwater Quantity Calculations – Describe drainage characteristics and conduct stormwater quality calculations.
- BMP Selections – Provide discussion of potential stormwater BMPs that could be implemented.
- Recommendations for Future Explorations – Provide recommendations for next steps.

1.6 Baseline Assumptions

The analysis included in this report was based on the following assumptions:

- This report was prepared to be consistent with City of Los Angeles LID Ordinance.
- This report includes an analysis of existing and proposed drainage systems and stormwater management, utilizing the area encompassing the maximum extent of physical disturbance associated with the proposed project (project footprint). Although this report reflects the quantities and exhibits associated with the proposed project, project-related drainage outside of Caltrans ROW would be managed similarly for the build alternative because the respective tributary drainage subwatersheds and storm drain systems would be affected similarly. This drainage nexus extends to the similarity of the stormwater quality approach.
- The elevated rail yard would be supported on cellular concrete fill. Tracks on cellular concrete are assumed to be 100 percent impervious. For a conservative approach in this preliminary plan, all

track and platform surfaces and the concourse building footprint (either proposed project or the build alternative) are considered to be impervious.

- Throat tracks are supported on cellular concrete fill up to the proposed tie-in location to existing tracks. Tracks at-grade are assumed to be 15 percent impervious, according to Appendix D (Proportion Impervious Data) of the *Los Angeles County Hydrology Manual*.
- The area south of US-101 includes street improvements on the newly realigned Commercial Street, Center Street, and adjacent properties. These areas are assumed to be 91 percent impervious.
- As part of the existing condition, LAUS is identified as railroads with open storage to account for the platforms and canopies. Railroads with open storage utilize a percent impervious value of 66 percent.
- A few pockets of lots adjacent to the proposed run-through track structures south of US-101 would be re-graded and are assumed to be "vacant undifferentiated" type, utilizing a percent impervious value of 1 percent.

Appendix A depicts the existing and proposed impervious surface where project-related impacts would occur. The impervious surfaces are also broken down by ROW under different jurisdictions. The estimate of total impervious surfaces for the existing and proposed project conditions for areas within the project footprint is shown in Table 1-1.

The total area within project study area is 110.90 acres.

Table 1-1. Summary of Impervious Surfaces

Condition	Area (acres)	Impervious Surface (%)	Impervious Surface (acres)
Existing	61.12	91	55.62
	14.42	66	9.52
	35.35	15	5.30
Existing Total	**110.90**	**64**	**70.44**
Proposed	35.61	100	35.61
	35.30	91	32.12
	32.96	15	4.94
	7.02	1	0.07
Proposed Total	**110.90**	**66**	**72.74**

Source: HDR 2018

2.0 Agency Requirements and Methodology

This section provides an overview of associated agency standards and guidelines that would shape the scope of the stormwater quality design, and the methodology to be used in this analysis.

2.1 Agency Standards and Guidelines

The following agency standards and guidelines were used to prepare this Preliminary LID Report:

- County of Los Angeles Hydrology Manual, 2006 (County of Los Angeles 2006)
- Planning and Land Development Handbook for Low Impact Development, Part B Planning Activities, Watershed Protection Division (City of Los Angeles 2016)
- *Development Best Management Practices Handbook*, Part A Construction Activities, Watershed Protection Division (City of Los Angeles 2004)
- Low Impact Development Standards Manual (County of Los Angeles 2014)
- Leadership in Energy and Environmental Design (United States Green Building Council 2013)
- California Green Building Standards Code (California Building Standards Commission 2013)
- Technical Manual for Stormwater BMP in the County of Los Angeles (County of Los Angeles 2004)

2.2 Methodology

2.2.1 Regulatory Setting

There are several related entities whose jurisdictions intersect with the project. Refer to the *Link US Water Quality Assessment Report* (HDR 2018) for additional information.

Construction General Permit (Order No. 2009-009-DWQ), adopted on September 2, 2009, became effective on July 1, 2010. This permit has since been amended twice by Orders No. 2010-0004-DWQ and 2012-0006-DWQ. The permit regulates stormwater discharges from construction sites that result in a Disturbed Soil Area of 1 acre or greater, and/or are smaller sites that are part of a larger common plan of development. The permit also includes post-construction stormwater standards that apply to jurisdictions not subject to a Phase I or II MS4 jurisdiction.

The City of Los Angeles is a permittee under the Phase I NPDES Permit and Waste Discharge Requirements for MS4 Discharges within the Coastal Watersheds of Los Angeles County, except those discharges originating from the City of Long Beach MS4, Order No. R4-2012-0175 (NPDES No. CAS004001). The NPDES permit prohibits discharges, sets limits on pollutants being discharged into receiving waters, and requires implementation of technology-based standards. These requirements are outlined in the LID Manual, Part B Planning Activities, Watershed Protection Division (City of Los Angeles 2016).

The portion of the project within Caltrans ROW is to be subject to NPDES Statewide Stormwater Permit Waste Discharge Requirements for Caltrans adopted on September 19, 2012 (as amended). This is a Phase I permit that applies statewide.

On February 5, 2013, the State Water Resources Control Board renewed the Phase II General Permit for the Discharge of Stormwater from Small MS4s General Permit (Order No. 2013-0001-DWQ) to provide permit coverage for smaller municipalities (population less than 100,000), including non-traditional Small MS4s, which are facilities such as military bases, public campuses, prisons, and hospital complexes. It became effective on July 1, 2013. The Phase II Small MS4 General Permit covers Phase II permittees statewide. Metro is not a Phase II permittee.

The California High-Speed Rail Authority was designated on August 22, 2014 as a Phase II entity subject to the Small MS4 General Permit. South of LAUS, for the proposed project and the build alternative, the planned HSR system would be on dedicated tracks with dedicated facilities, and this portion of the project would be under the jurisdiction of the Phase II permit.

The City of Los Angeles LID Ordinance (consistent with Los Angeles County NPDES MS4 Permit, Order No. R4-2012-0175) is assumed to be more stringent than the Phase II requirements for which California High-Speed Rail Authority is subject to compliance. Due to the project being designed to be consistent with the City of Los Angeles LID Ordinance (non-Caltrans ROW), California High-Speed Rail Authority Phase II requirements would be met or exceeded.

2.2.2 Low Impact Development Compliance

For development that results in an alteration of at least 50 percent or more of the impervious surface of an existing developed site, the entire site would be consistent with the City of Los Angeles LID Ordinance. The project would include 66 percent of impervious area, per Table 1-1, based on the assumptions identified in Section 1.6, and it falls under the “All Other Developments” category. The project would be designed to be consistent with the requirements of the LID Manual.

2.2.3 Hydromodification

Projects that drain into the natural drainage systems in a small part of the Upper Los Angeles River Area would apply hydromodification control. Per Appendix J of the LID Manual, which shows the extents of the Upper Los Angeles River Area, the project study area is not located in the Upper Los Angeles River Area. Furthermore, the Los Angeles River adjacent to the project study area is entirely concrete lined. Hydromodification control is not required for the project.

2.2.4 Prioritization of Best Management Practice Selection

According to the LID Manual, the following is the priority order for implementing BMPs:

1. Infiltration Systems
2. Stormwater Capture and Use
3. High Efficiency Biofiltration/Bioretention Systems
4. Combination of Any of the Above

Infiltration Feasibility Screening

Infiltration systems are the first priority type of BMP improvements, as they provide for percolation and infiltration of the stormwater into the ground, which not only reduces the volume of stormwater runoff entering the MS4, in some cases they can also contribute to groundwater recharge. If stormwater infiltration is not possible based on the project site conditions, the developer will utilize the next priority BMP.

According to the *Link US Phase I Environmental Site Assessment* (HDR 2016a), there are active oil and gas reserves located through the City of Los Angeles. Adjacent to the project is the Union Station Oil Field. Naturally occurring oil seeps have also been documented throughout the project study area. Surface oil stains were also noted within the railroad tracks on the ballast material. Groundwater samples taken from the United States Postal Service Terminal Annex property, located adjacent to Segment 1: Throat Segment, detected total petroleum hydrocarbons, volatile organic compounds, and chlorinated solvents, which are contaminants of concern. Based on these considerations, the majority of the soil in the project study area is contaminated and not suitable for proposed infiltration. Therefore, unlined landscaping improvements, including irrigation, are not feasible.

The area where existing tracks are currently at-grade would still be able to support infiltration.

Capture and Use Feasibility Screening

Capture and use, commonly referred to as rainwater harvesting, collects and stores stormwater for later use, thereby offsetting potable water demand and reducing pollutant loading to the storm drain system. Sufficient landscaped area with appropriate water demand, to which the captured runoff can be directed, is needed. Partial capture and use can also be achieved as part of a treatment train by directing the overflow to a bioretention system. This can provide additional volume-reduction and water quality treatment in instances where the quantity of runoff from a storm event exceeds the volume of the collection tank.

In the City of Los Angeles, the use of collected stormwater is primarily limited to landscape irrigation. Landscape soil must contain suitable fill material. Excavation and replacement of contaminated or otherwise inadequate soil may be required. Use of landscaped areas for the collection of stormwater is subject to review and approval via the City of Los Angeles Land Development Plan Check procedure.

It is anticipated that the proposed capture and use system would supply water for landscape irrigation only. Water for toilet flushing may be considered as an option for use of stormwater during final design, as there may be insufficient landscape area to meet capture and use requirements. Other uses for treated stormwater, such as toilet flushing or cooling tower makeup, would require further study and compliance with city, regional, and/or state codes. This would be investigated further during the plan, specification, and estimate phase.

A cistern is proposed as the capture and use BMP system. Please see Section 5.2.1 for a detailed description of cisterns.

Bioretention with Underdrain

Projects that have demonstrated that 100 percent of the water quality design volume cannot be managed on-site through Tier 1 (infiltration) and/or Tier 2 (capture and use) may utilize Biofiltration/Bioretention for the remaining volume. Biofiltration/Bioretention BMPs would need to capture 1.5 times the design volume not managed through capture and use. Biorentention facilities are landscaped shallow depressions that capture and filter stormwater runoff. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and bio-degraded by the soil and plants.

As stated above, the project site is contaminated; therefore, it does not pass the infiltration screening. An impermeable liner would be needed to prevent incidental infiltration.

2.2.5 Other Stormwater Management Measures

Natural Areas

There are no natural areas within the project footprint for the proposed project or the build alternative.

Slopes and Channels

The Los Angeles River runs directly east of the project study area. The portion of the Los Angeles River adjacent to the project study area is entirely concrete lined. No modifications to the Los Angeles River Channel would be required.

Slopes would be vegetated within the project footprint for the proposed project or the build alternative.

Storm Drain Stenciling and Signage

Storm drain stencils would be provided at all new or affected drain inlets and catch basins within the project footprint for the proposed project or the build alternative.

3.0 Pollutants of Concern

The project is located within the Los Angeles River Watershed (Figure 3-1).

Table 3-1 shows the pollutant assessments for Los Angeles River Watershed (Los Angeles River Reach 2) as determined by the 2014/2016 Section 303(d) impaired waters list.

The POC for Los Angeles River Reach 2, which is adjacent to the project, are:

- Ammonia
- Copper
- Indicator bacteria
- Nutrients (algae)
- Oil
- Trash

These POCs will be the same for US-101 after Caltrans updates the Water Quality Planning Tool. The land uses include a mixture of developed educational, extraction, industrial, retail, and commercial properties. Other sources referenced for identifying POC are the California Stormwater Quality Association Stormwater BMP Handbook for New Development and Redevelopment (California Stormwater Quality Association 2009), and the Clean Water Act Section 303(d) List (California Environmental Protection Agency 2016).

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Figure 3-1. Los Angeles River Watershed Map

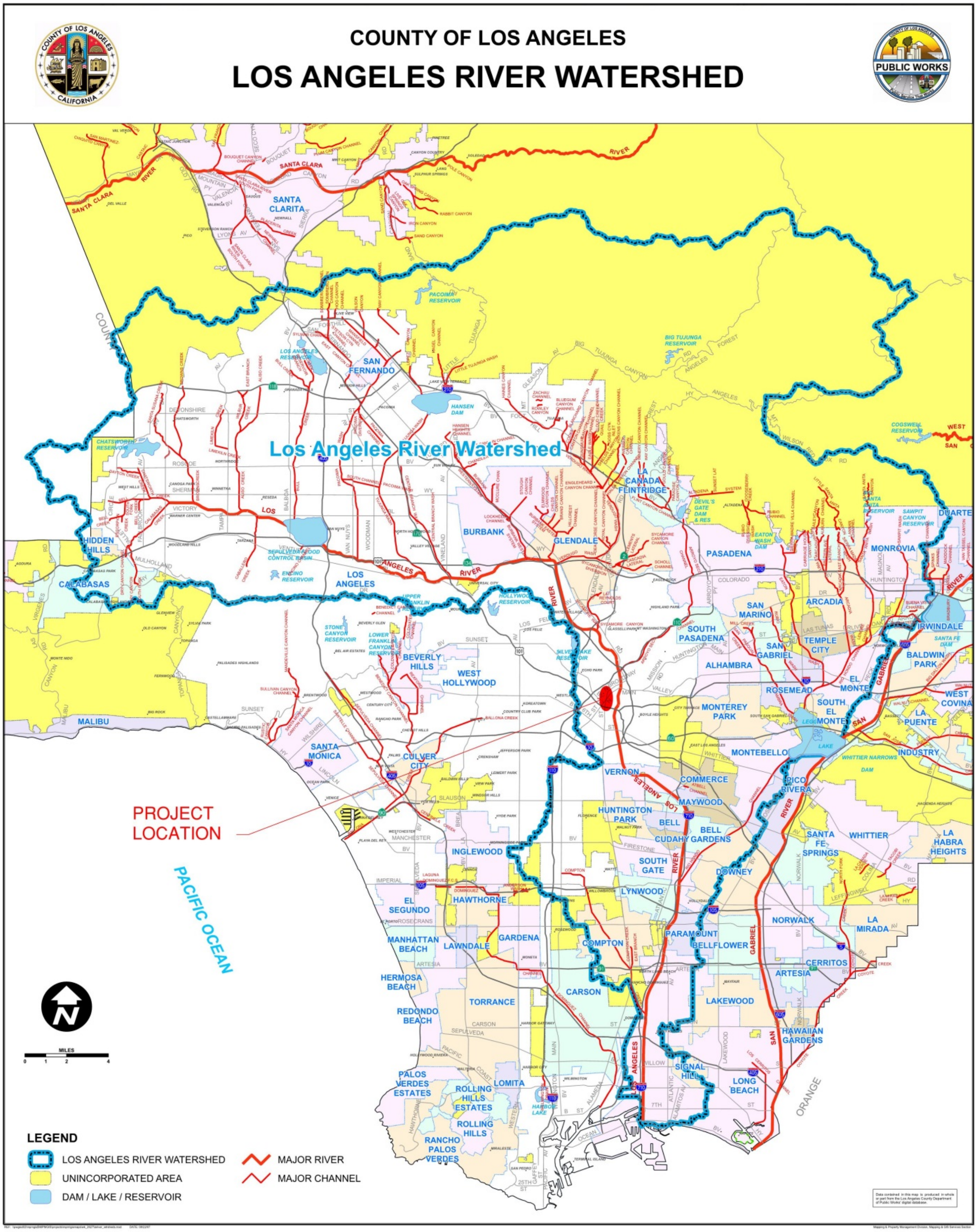

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Table 3-1. Pollutant Assessment for Los Angeles River Watershed: Los Angeles River Reach 2 (Carson to Figueroa Street)

Pollutants	Listing Decision	Detailed Report	Potential Sources	Schedule
Ammonia	List on Section 303(d) list (being addressed by U.S. EPA approved TMDL)	18253	—	U.S. EPA TMDL approval: 2004
Indicator Bacteria	List on Section 303(d) list (being addressed by U.S. EPA approved TMDL)	20674	—	Est. TMDL completion: 2012
Copper	List on Section 303(d) list (being addressed by U.S. EPA approved TMDL)	19818	—	U.S. EPA TMDL approval: 2005
Nutrients (Algae)	List on Section 303(d) list (being addressed by U.S. EPA approved TMDL)	18196	—	U.S. EPA TMDL approval: 2004
Oil	List on Section 303(d) list (TMDL required list)	20676	—	TMDL required list
Trash	List on Section 303(d) list (being addressed by U.S. EPA approved TMDL)	18022	—	U.S. EPA TMDL approval: 2008

Source: California Environmental Protection Agency 2016

Notes:
TMDL=total maximum daily load; U.S. EPA=United States Environmental Protection Agency,

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4.0 Stormwater Quantity Results

4.1 Hydrology

LID calculations for the water quality volume and flow are based on the City of Los Angeles LID Manual (City of Los Angeles 2016), and County of Los Angeles Department of Public Works, LID, *Standards Manual* (County of Los Angeles 2014).

Current water quality requirements are based on treating a specific volume of stormwater runoff from the project site (Stormwater Quality Design Volume). By treating the Stormwater Quality Design Volume, it is expected that pollutant loads, which are typically higher during the beginning of storm events, would be reduced in the discharge or prevented from reaching the receiving waters. The design storm, from which the Stormwater Quality Design Volume is calculated, is defined as the greater of: the 0.75-inch, 24-hour rain event; or the 85th percentile, 24-hour rain event as determined from the Los Angeles County 85th percentile precipitation isohyet map

According to the Los Angeles County 85th percentile precipitation isohyet map (County of Los Angeles n.d.), the 85th percentile 24-hour rainfall equals 1.0 inch and soil type 006 (Figure 4-1).

The HydroCalc program was used to calculate the Stormwater Quality Design Volume.

Table 4-1 in Section 4.3 details the mitigated volume for each area and Appendix B details supporting calculations.

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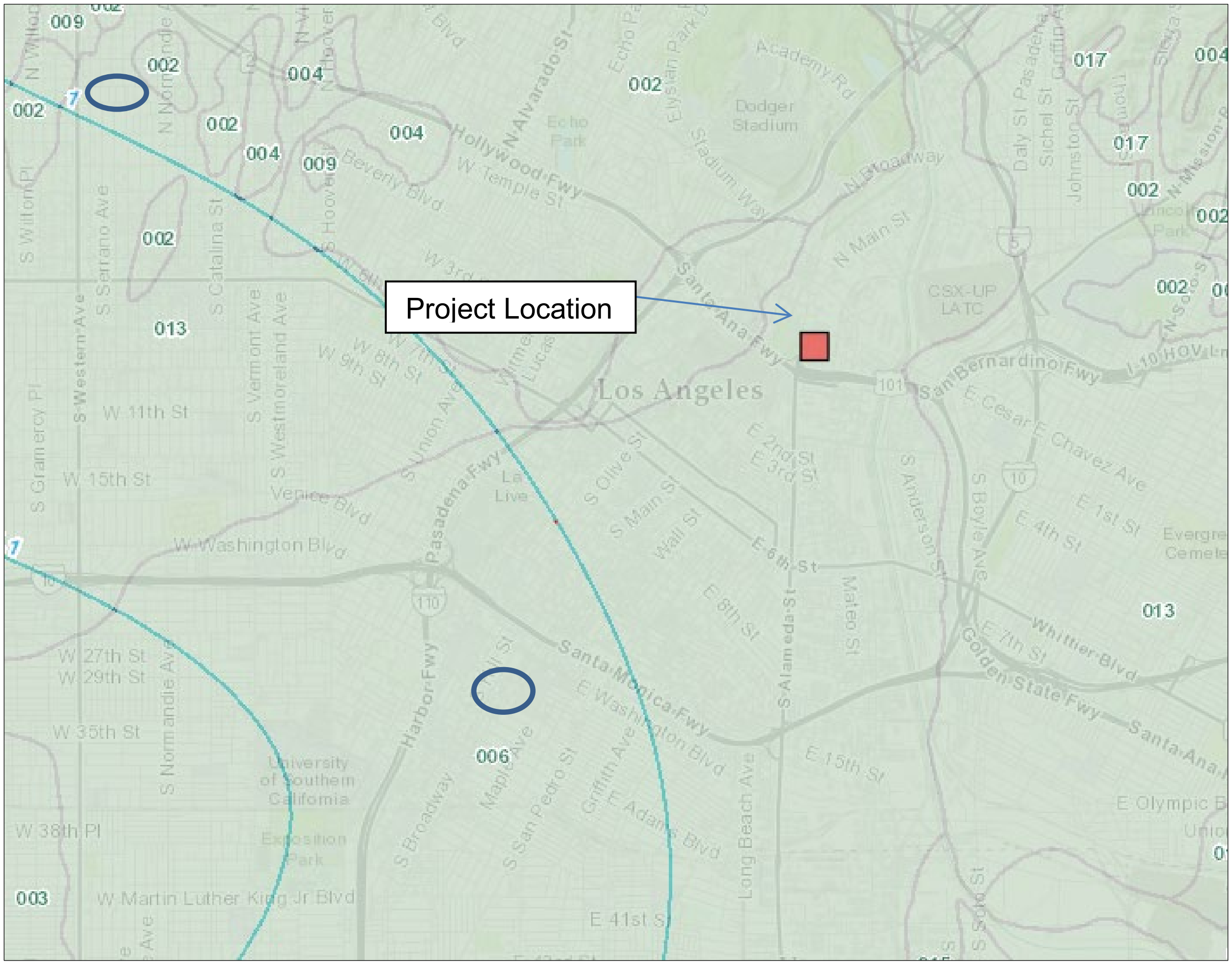
Figure 4-1. Hydrology Map Showing 85th Percentile, 24-hour Rainfall, and Soil Type



Source: County of Los Angeles 2006

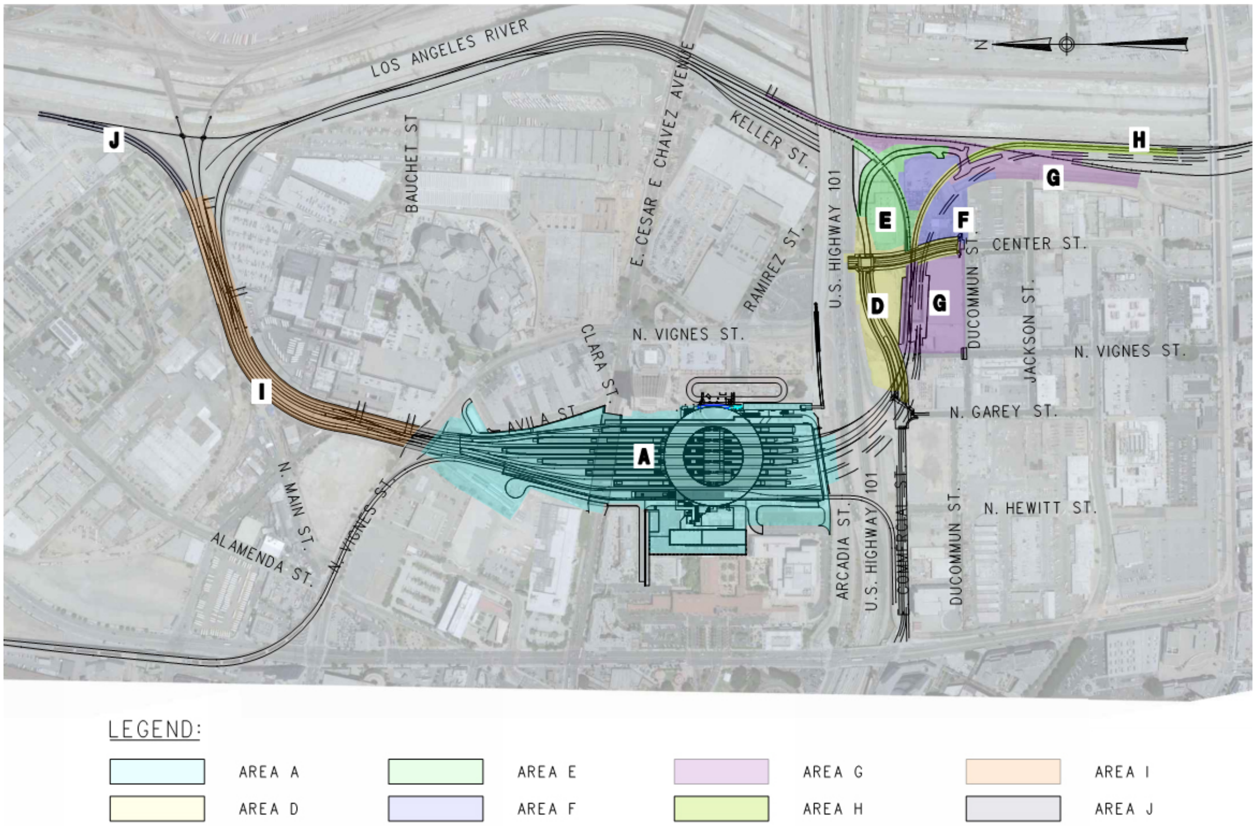
4.2 Post-Construction Drainage

For detailed existing drainage information, please the *Expanded Preliminary Drainage Technical Memorandum* (HDR 2016b).

The site has eight major drainage areas, which are identified as Areas A, D, E, F, G, H, I, and J for LID evaluation and shown on Figure 4-2 as an overview. Drainage subareas for each major drainage area are detailed in Appendix C, Preliminary LID exhibit.

For the BMPs proposed for each area/subareas, see Section 5.0 for details.

Figure 4-2. Overview of Major Drainage Areas for Post-Construction Conditions



4.2.1 Tributary Area A

To maintain the existing drainage pattern, and implement a stormwater treatment system, Tributary Area A was divided into eight sub-areas in order to analyze the capture and conveyance of stormwater to the appropriate location for treatment.

Specific descriptions of each sub-area are provided below. The study area has two points of connection to the existing municipal storm drain system:

1. 108-inch reinforced concrete pipe (RCP) in Cesar Chavez Avenue just to the east of the Cesar Chavez Bridge
2. 138-inch reinforced concrete arch in the US-101.

Both existing systems ultimately discharge to the Los Angeles River.

Runoff from the rail yard area would drain into a ballasted track bed supported by a cellular concrete slab on-grade. The cellular concrete slab on-grade would slope away from the tracks and direct runoff into the underdrains (8-inch-diameter perforated corrugated metal pipes) running adjacent and parallel to the tracks. These underdrains would be connected to a cross-drain line (36-inch RCP) that would then connect to a Stormwater Capture System (cistern). Details on the cistern are in Section 5.1. The Stormwater Capture

System will treat stormwater for use and detain and attenuate overflow before conveyance to one of the two existing municipal storm drain systems previously mentioned. All stormwater that is not utilized on-site will be discharged to the municipal storm drain system.

Runoff from the rail yard north of the passenger tunnel (Sub-Areas A1, A2, and A4) is tributary to the Garden Track Cistern (Appendix C details the location) and discharge to the municipal storm drain in Cesar Chavez Avenue. The rail yard south of the passenger tunnel, the west plaza, the baggage handling building, and adjacent parking areas (Sub-Areas A3, A5, A6, and A8) are tributary to the West Plaza Cistern (Appendix C details the location) and discharge to the municipal storm drain in US-101.

The proposed project with an above-grade passenger concourse was chosen for this analysis although the impact would be the same as the build alternative, with an at-grade passenger concourse, as both options are assumed to be 100 percent impervious surface.

- Sub-Area A1 – Sub-Area A1 primarily encompasses the throat portion of the rail yard and the portion of the rail yard known as the garden track area, both located north of Cesar Chavez Avenue. Precipitation that falls in these two areas is collected and conveyed to the proposed Garden Track Cistern for treatment, located north of Cesar Chavez Avenue in the Garden Track area. Treated runoff and overflow is conveyed to the existing municipal storm drain system in Avila Street, which eventually outlets to the 108-inch City of Los Angeles storm drain pipe in Cesar Chavez Avenue.
- Sub-Area A2 - Sub-Area A2 encompasses the portion of the main rail yard between Cesar Chavez Avenue and the existing passenger tunnel that connects to the East Portal building. Precipitation that falls in this area of the rail yard is collected and conveyed to the proposed Garden Track Cistern for treatment and detention. Treated runoff and overflow is conveyed from the cistern to the existing municipal storm drain system in Avila Street which connects to the 108-inch City of Los Angeles storm drain pipe in Cesar Chavez Ave, and ultimately discharges to the Los Angeles River.
- Sub-Area A3 – Sub-Area A3 encompasses the portion of the rail yard between the existing passenger tunnel and the access road along the southern end of the platforms. Precipitation that falls in this area is collected and conveyed to the proposed West Plaza Cistern for treatment and detention. Treated runoff and overflow is conveyed to the existing 138-inch arch pipe in the US-101, which ultimately discharges to the Los Angeles River.
- Sub-Area A4 – Sub-Area A4 is primarily made up of the slope to the east of the garden track and west of the postal annex building. The area slopes to the west, away from the Union Station property. Runoff from this area will be collected and conveyed to the proposed Garden Track Cistern for treatment and detention. As the design progresses, the method of conveyance to the cistern will need to be further assessed. Overflow and treated runoff will be conveyed to the existing storm drain system in Avila Street which connects to the 108-inch City of Los Angeles storm drain pipe in Cesar Chavez Ave, and ultimately discharges to the Los Angeles River.
- Sub-Area A5 – Sub-Area A5 encompasses the west plaza, the baggage handling building, adjacent parking, and the proposed loading dock. Precipitation that falls into this area is collected and

conveyed to the proposed West Plaza Cistern for treatment and detention. Overflow and treated runoff is conveyed to the existing 138-inch arch pipe in the US-101, which ultimately discharges to the Los Angeles River.

- Sub-Area A6 – Sub-Area A6 encompasses the slope to the south of the west plaza between the Metropolitan Water District of Southern California building and the access road. Precipitation that falls in this area is collected and conveyed to the proposed West Plaza Cistern for treatment and detention. Overflow and treated runoff is conveyed to the existing 138-inch arch pipe in the US-101, which ultimately discharges to the Los Angeles River.
- Sub-Area A7 – Sub-Area A7 primarily includes the walkway along the west side of Patsaouras Transit Plaza. This area is not tributary to the rail yard, but rather is part of the Patsaouras Transit Plaza drainage system. This area is included in the analysis as the area is affected by the proposed improvements. As a result of the proposed improvements, the area of Sub-Area A7 is reduced from 1.1 acres in the preconstruction condition down to 0.7 acre in the post-construction condition. The difference of 0.4 acre, which is tributary to Patsaouras Transit Plaza in the preconstruction condition, becomes tributary to the rail yard in the post-construction condition. This reduction in area reduces the total runoff flow and directs it to the treatment system at the West Plaza Cistern, effectively improving the drainage condition in the Patsaouras Transit Plaza drainage system.
- Sub-Area A8 – Sub-Area A8 encompasses a small portion of the viaduct crossing over the US-101 and is included to account for the small volume of runoff that is not captured in the catch basins on the viaduct.

If the build alternative with an at-grade passenger concourse were implemented, the hydrology analysis will require minimal or no change in Area A, as the entire concourse study area was assumed to be fully impervious. The cistern concept would remain the same. The drainage pattern mimics the existing condition drainage pattern, and therefore, would also not change as a result of the concourse option.

4.2.2 Tributary Area D

Area D encompasses the area along Center Street, between Ducommun Street and under US-101, and proposed Commercial Street (realigned), west of Center Street and slopes at south. For the proposed project or the build alternative, deck drainage from the overhead viaduct would be tied into existing drainage systems. The existing 18-inch vitrified clay storm drain pipe (built in 1909) running along Commercial Street is connected to a 24-inch/36-inch storm drain pipe running along Center Street. This pipe connects to a 138-inch arch pipe system located within the freeway ROW that runs easterly across the El Monte Busway and US-101, southerly along Vignes Street, then easterly along Ducommun Street, and ultimately discharges to the Los Angeles River. The proposed project or the build alternative includes realignment of Commercial Street, resulting in removal and realignment of a portion of the existing 18-inch vitrified clay storm drain.

- Sub-Area D1 – Sub-Area D1 primarily encompasses the proposed realigned Commercial Street, west of red line tunnel. Due to constraints on running a storm drain pipe across the red line tunnel, the runoff from this area would be routed to the 138-inch arch pipe earlier at Vignes Street, while for the existing condition, the run off from existing Commercial Street drains to the storm drain pipe running along Center Street, which eventually drains to the 138-inch arch pipe.

- Sub-Area D2 – Sub-Area D2 primarily encompasses the slopes south of proposed Commercial Street and north of the proposed run-through regional tracks. The runoff from the slope will drain to a proposed v-ditch, which drains to an inlet connecting to the storm drain pipe on Center Street. The slopes would be impervious with landscaping.
- Sub-Area D3 – Sub-Area D3 primarily encompasses Center Street and proposed Commercial Street east of Red Line Tunnel, and a portion of the proposed Division 20 access road east of Center Street. The runoff from streets will drain to catch basins and inlets on the street, which connect to the storm drain pipe on Center Street.

4.2.3 Tributary Area E

Area E primarily encompasses the area between Aliso Street to the north, Center Street to the West, Ducommun Street to the South, and the Los Angeles River to the east, and includes the loop track and proposed Metro Division 20 access road. A portion of the existing 22-inch vitrified clay storm drain system (in the area where the existing Commercial Street is located), which drains to the Los Angeles River, would be preserved. Track drainage from the loop track would be collected from a track underdrain, which drains to the 22-inch drain system. Runoff within this area would be collected via catch basins draining to the 22-inch storm drain system and ultimately to the Los Angeles River.

- Sub-Area E1 – Sub-Area E1 primarily encompasses the graded, pervious area north of proposed loop track and south of Metro's Division 20 access road. The runoff from this area drains to the low point where an inlet is proposed and connected to the existing 22-inch pipe on existing Commercial Street.
- Sub-Area E2 – Sub-Area E2 primarily encompasses the drainage area of loop track and Metro's Division 20 access road. The runoff from this area flows to a trench drain located at the low point of access road and track underdrains, and eventually drains to the existing 22-inch pipe at the location close to the Los Angeles River.

4.2.4 Tributary Area F

Area F encompasses the area of Division 20 Red Line Portal Trench and parking lot, and Metro-owned property. Runoff within this area drains to the existing 138-inch arch pipe system, which discharges to the Los Angeles River.

- Sub-Area F1 – Sub-Area F1 primarily encompasses the Division 20 Red Line Portal Trench and proposed parking.
- Sub-Area F2 – Sub-Area F2 primarily encompasses the Metro-owned property where hazardous soils are stored. The drainage pattern for this area will remain the same.

4.2.5 Tributary Area G

Area G is primarily composed of the drainage tributary area to the 42-inch RCP system along Ducommun Street. It primarily encompasses the run-through tracks on the embankment structure between Vignes Street and Center Street, the Southern California Regional Rail Authority maintenance access road next to the tracks, and slopes at south, and includes the BNSF Yard and the main line tracks on the west bank of the Los Angeles River.

- Sub-Area G1 – Sub-Area G1 primarily encompasses the run-through tracks on the embankment structure and Southern California Regional Rail Authority maintenance access road. Runoff would drain to the dirt trapezoidal ditch and would be collected into inlets which drain to a 42-inch RCP system along Ducommun Street and ultimately discharge to the Los Angeles River.
- Sub-Area G2 – Sub-Area F2 primarily encompasses the slopes at south of the run-through tracks and future HSR tracks. The runoff from the slope would drain to a proposed v-ditch, which drains to an inlet ultimately connecting to the 42-inch pipe along Ducommun Street. The slopes would be impervious with landscaping.
- Sub-Area G3 – Sub-Area G3 primarily encompasses Ducommun Street between Vignes Street and Center Street. The Drainage pattern will remain the same as the existing condition.
- Sub-Area G4 – Sub-Area G4 primarily encompasses Southern California Regional Rail Authority track, BNSF tracks, and Amtrak track by the Los Angeles River. The runoff will drain to track underdrains connecting to the 42-inch RCP.

4.2.6 Tributary Area H

Area H encompasses the run-through tracks that are located south of Ducommun Street and become parallel to the west bank of the Los Angeles River. Track underdrains collecting track runoff drain to an existing inlet located at the concrete ditch by the west bank of Los Angeles River.

4.2.7 Tributary Area I

Proposed throat tracks and rail access roads north of Vignes Street are located within this area. The majority of the southern portion of the track bed would be supported by a cellular concrete slab on-grade that is sloped away from the tracks and designed to direct runoff into perforated underdrains located adjacent to the tracks. The proposed storm drain line along the rail access roads would collect the runoff from the underdrains and drain south, to the 66-inch RCP at Vignes Street.

4.2.8 Tributary Area J

Area J encompasses the northernmost tracks for the project, parallel to Bolero Lane, north of Bloom Street. An existing 30-inch RCP collects the runoff from an existing funnel intake and an existing concrete ditch located along Bolero Lane and discharges to the Los Angeles River. Track underdrains collecting track runoff drain to this existing 30-inch RCP.

4.2.9 California Department of Transportation Right-of-Way

Stormwater collected on the common structure/deck over US-101 would be collected through a series of inlets in the center of the structure and then directed, untreated, to the Caltrans on-site drainage system through one of the structure's columns. See the *Conceptual Drainage Study Report* (WKE 2016) and the *Draft Stormwater Data Report* (WKE 2018) for more information. It is assumed that only a very small amount of stormwater north of the Caltrans ROW would be added to this area. The BMP approach for the stormwater within Caltrans ROW would be further investigated during plan, specification, and estimate phase, in cooperation with Caltrans.

4.3 Stormwater Quality Calculations

Table 4-1 is a summary of stormwater quality calculations using the 85th percentile, 24-hour rain event. See Appendix B for HydroCalc calculations.

Table 4-1. Low Impact Development Stormwater Quality Calculations

Area ID	Sub-Area	Area (acres)	Impervious Surface (%)	Water Quality Flow (cubic feet per second)	Water Quality Runoff Volume (cubic feet)
A	A1	7.38	100	1.66	23,912
	A2	5.49	100	1.36	17,788
	A3	6.66	100	1.71	21,579
	A4	0.58	100	0.16	1,879
	A5	2.62	100	0.67	8,489
	A6	0.70	100	0.20	2,268
	A7	0.70	91	0.14	2,086
	A8	0.39	100	0.13	1,264
	Total	**24.52**	—	**6.02**	**79,264**
D	D1	6.90	94	1.62	21,163
	D2	3.77	91	0.95	11,237
	D3	2.43	91	0.57	7,243
	Total	**13.10**	—	**3.14**	**39,643**
E	E1	1.12	10	0.02	435
	E2	1.79	62	0.30	3,840
	Total	**2.91**	—	**0.32**	**4,275**
F	F1	1.49	47	0.29	2,557
	F2	1.07	91	0.31	3,189
	Total	**2.56**	—	**0.60**	**5,746**
G	G1	0.65	12	0.04	459
	G2	1.95	1	0.06	758
	G3	0.94	91	0.22	2,802

Table 4-1. Low Impact Development Stormwater Quality Calculations

Area ID	Sub-Area	Area (acres)	Impervious Surface (%)	Water Quality Flow (cubic feet per second)	Water Quality Runoff Volume (cubic feet)
	G4	3.43	15	0.10	2,717
	Total	**6.97**	**—**	**0.42**	**6,736**
H	H	0.97	15	0.03	768
	Total	**0.97**	**15**	**0.03**	**768**
I	I	5.01	63	0.63	10,894
	Total	**5.01**	**63**	**0.63**	**10,894**
J	J	0.86	15	0.03	681
	Total	**0.86**	**15**	**0.03**	**681**

Source: HDR 2018

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5.0 Best Management Practice Selection

Implementation of unlined infiltration BMPs or Green Street Standards on impacted streets are infeasible because of existing site conditions, as described above. There may be opportunities to implement lined infiltration BMPs or bioretention BMPs as Green Street BMPs at select locations. Further evaluation would be performed in the plan, specification, and estimate phase. See Section 5.1.3 for more information. The proposed BMPs selected for implementation are summarized below:

- For drainage area A, capture and use (cistern) is the preferred BMP. If the amount of collected stormwater cannot be 100 percent used, other bioretention BMP should be considered for the remaining volume. As the project design progresses, water demand analysis for capture and use should be conducted to determine capacity constraints.
- For drainage areas D, E, F, and G, bioretention BMPs with underdrains and impermeable liners (i.e., no infiltration) are proposed.
- Drainage area J is very challenging because of its location, as there is no good location for capture and use or bioretention BMPs given that it is within the railroad ROW. Therefore, capture and use and bioretention BMPs are infeasible. A Contech StormFilter (stormwater vault with filter cartridges) is proposed for this area.

The detail and sizing of selected BMPs are as below.

5.1 Capture and Use (Cistern)

5.1.1 Description

Stormwater from the tributary areas would discharge into a water quality unit for pre-treatment prior to discharging into the cistern for storage. A mechanical skid unit would manage the distribution of the captured stormwater for use (i.e., for irrigation). The mechanical skid, being the "brain" of the system, activates the pump to convey water to the irrigation system when it detects water in the cistern. If water uses inside the proposed passenger concourse are pursued, post-treatment (filter and ultraviolet [UV] system) would be required. In the UV system, UV light sterilizes the pretreated water; this is described further at the end of this section.

Capture volume must be equal to or less than the Estimated Total Water Usage from October 1 to April 30, as prescribed by the landscape architect. According to the LID Manual, the use of treated stormwater is primarily limited to irrigation of landscaped surfaces that have an impermeable lining. Excavation and replacement of new fill material may be required because of the potential for contaminated soils.

As new guidelines and guidance become available, the potential use of graywater for irrigation and/or flushing toilets may be considered. The demands for graywater would be dictated by fixture unit counts, as defined by the plumbing engineer. In order for water to be utilized in fixture units, the water must comply with California Code of Regulations Title 22 regulations, Section 60301.230 Disinfected Tertiary Recycled Water Code requirements.

For the first year after installation of the cistern, it is recommended that the system be inspected quarterly. After the first year, annual inspections are recommended. Inspections should include checking of the inlet, outlet, and cistern overflow for potential blockages and accumulated sediment.

Pre-Treatment (Baffle Boxes)

Baffle boxes are a possible pre-treatment measure that could also be implemented. Baffle boxes are concrete or fiberglass structures containing a series of sediment settling chambers separated by baffles. The primary function of baffle boxes is to remove sediment, suspended particles, and associated pollutants from stormwater. Baffle boxes may also contain trash screens or skimmers to capture larger materials, trash, and floatables.

Post-Treatment (Ultraviolet System)

The UV system is a possible post-treatment for the project. In the UV system, UV sterilizers expose water to a specific wavelength of UV light that destroys the DNA of organisms present and keeps the water sterile. Sizing of the UV system is critical to maintain sufficient exposure rates to keep the water sterile.

The advantages of UV sterilization is that chemicals are not used to kill pathogens, systems typically require minimal maintenance, and they are often less expensive than chlorination systems. If pursued, the UV system would be used in addition to the pre-treatment system.

5.1.2 Cistern Sizing

The following are preliminary dimensions for each cistern unit. Appendix D shows the Stormwater Process Diagram and illustrates the treatment train for the proposed cisterns. Appendix E contains cistern details from a sample manufacturer.

- Width = 7 feet
- Length = 15 feet
- Depth = 14 feet

The cistern manufacturer is still being determined because the project is at the preliminary stage. A cistern manufacturer analysis would be conducted in the future to assist Metro in selection of a cistern manufacturer. For the time being, the cistern sizes of 12,028 gallons (1,608 cubic feet) provided by OldCastle's StormCapture Tank will be used as a reference. As stated in Section 4.1, the required design volume is 77,179 cubic feet, which is shown in Table 5-1 below; in addition to the number of cistern units required for the concourse area (Exhibit 2 in Appendix A). The manufacturer may need to be National Sanitation Foundation-350 certified for use of treated water inside the building (i.e., flushing toilets).

Table 5-1. Summary of Cistern Sizing (Low Impact Development) for Tributary Area A

Sub-Area	Required Volume (cubic feet)	Receiving Cistern
A1	23,912	Garden Track
A2	17,788	Garden Track
A3	21,579	West Plaza
A4	1,879	Garden Track
A5	8,489	West Plaza
A6	2,268	West Plaza
A8	1,264	West Plaza
Total	**77,179**	—

Source: HDR 2018

5.1.3 Build Alternative with At-Grade Passenger Concourse

For the build alternative with an at-grade passenger concourse, the cistern concept would remain the same as the proposed project, as will the cistern volumes because both concourse options are assumed to be 100 percent impervious surface. The drainage pattern mimics the existing condition drainage pattern, and would also not change as a result of the concourse option implemented.

5.2 Bioretention

Bioretention with underdrains are proposed in landscaped shallow depressions that capture and filter stormwater runoff. An impermeable liner (i.e., no infiltration) would be included for each bioretention BMP with an underdrain to convey overflow to a nearby existing storm drain system. This BMP is proposed for drainage areas D1, D3, and E2. It has been determined that this BMP is not feasible for other drainage areas. There is also an opportunity to use bioretention BMPs as part of Green Street features along Commercial Street, Center Street, and Ducommun Street. City of Los Angeles Green Street Standard Plans may be used and modified with bioretention features and impermeable liners to convey the underdrains to a nearby storm drain system. This approach would require concurrence from the City of Los Angeles.

5.2.1 Bioretention Sizing

Calculations were based on the LID Manual (see Appendix B for City of Los Angeles LID Sample Design Calculation).

$$A_{min} = \frac{V_{Design}}{\left[\left(\frac{T_{fill} \times K_{Sat,Design}}{12}\right) + d_p\right]}$$

See Table 5-2 for input parameters.

Table 5-2. Bioretention Sizing Parameters

Parameters	Symbol	Value	Unit	Notes
Mitigated Volume	VM	—	cubic feet	Value per HydroCalc
Measured Infiltration Rate	Ksat, media	5	inch/hour	Assumed 5 inches/hour
Factor of Safety	FS	6	—	FS=2 if soil infiltration test and geotechnical report from professional geotechnical engineer is done; FS=6 if only a boring was done; soil infiltration rate to be determined by geotechnical engineer.
Design Infiltration Rate	Ksat, design	2.5	inch/hour	—
Time to fill	Tfill	3	hours	T=3 hours, unless a hydrologic routing model is used
Maximum Ponding Depth	dp, max	1	feet	18 inches or 12 inches
Design Volume	Vdesign	2.5	inch/hour	—

Source: HDR 2018

See Table 5-3 below for the estimated bioretention footprint to meet LID requirements. Appendix F details sizing calculations. A ponding depth of 12 inches is assumed for this preliminary sizing.

Table 5-3. Summary of Bioretention Sizing

Area	Footprint (square feet)	Bioretention BMP
D1	1,967	Bioretention with Underdrain
D3	6,360	Bioretention with Underdrain
E2	3,372	Bioretention with Underdrain

Source: HDR 2018

Notes:
BMP=best management practice

5.3 Other Best Management Practices

Drainage Area D2, E1, and G2 are pervious areas with landscaping. No BMP is evaluated for these areas.

Runoff from drainage Area G1 flows to the dirt trapezoidal ditch which could be used as stormwater treatment facilities. More information on stormwater will be provided as the project design progresses.

The majority of drainage Area F1 is associated with Metro's Division 20 Red Line Portal project. No BMP is evaluated for this area.

No improvements are proposed for drainage area F2; therefore, no BMP is evaluated for this area.

No BMP is evaluated for drainage area J, which is composed of tracks on-grade.

Drainage area I is challenging because of its location. There is no good location for capture and use or biotention BMP given that it is within the railroad corridor. Therefore, capture and use and bioretention BMP are infeasible. It is proposed to use a Contech StormFilter (stormwater vault with filter cartridges) for drainage area J. See Appendix G for more information.

Drainage area H is on cellular concrete fill, and it has the same constraints posed by drainage area J. It is proposed to use a Contech Jellyfish Filter. See Appendix G for more information.

5.4 Summary

The proposed BMP is summarized as below:

- In Segment 1: Throat Segment, a structural stormwater vault would address the area north of Vignes Street; a capture and use BMP (cistern) would address the rest of this segment, including a portion of the concourse area (Segment 2: Concourse Segment). For the build alternative, modification of local city streets (Bolero Lane, Bloom Street, and Leroy Street) would occur, and the drainage pattern will remain the same as the existing condition. Implementation of the City of Los Angeles Green Street Standards would be applied at this location, similar to the BMPs proposed in Segment 3: Run-Through Segment.
- In Segment 2: Concourse Segment, capture and use BMP (cisterns) are proposed. The extent of BMPs in the concourse area will be refined in final design. For the build alternative with an at-grade passenger concourse, the cistern concept will remain the same as the proposed project.
- In Segment 3: Run-Through Segment, south of US-101, bioretention BMPs are proposed for the proposed project and the build alternative. Bioretention BMPs would be applied on reconstructed public streets south of US-101 (i.e., Commercial Street, Center Street, and Ducommun Street). City of Los Angeles Green Street Standard Plans may be used and modified with bioretention features and impermeable liners to convey the underdrains to a nearby storm drain system. This approach would require concurrence from the City of Los Angeles. A structural BMP (Contech Jellyfish Filter) would address the area south of Ducommun Street where the tracks sit on the cellular concrete.

6.0 Recommendations for Future Explorations

The project team has met with the City of Los Angeles Bureau of Engineering to discuss the City's LID requirements and to present the preferred conceptual BMP approach. See the meeting minutes in Appendix H.

This Preliminary LID Report highlights preliminary stormwater quality analysis and BMP options. Tier 1 (infiltration) is not feasible because of site constraints; however, Tier 2 (capture and use) and Tier 3 (bioretention) are viable approaches to meet LID requirements.

The following steps are recommended for further evaluation:

- Conduct water demand analysis for capture and use cisterns. If after further analysis determines 100 percent of the water quality design volume cannot be managed through capture and use, the remaining volume is proposed to be managed through bioretention BMPs.
- Conduct further exploration of other BMP options as the engineering design progresses.
- Update this Preliminary LID Report after selection of post-construction BMP designs and consideration of operations and maintenance costs for each BMP.

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Appendix A:
Existing and Proposed Impervious Area Exhibit

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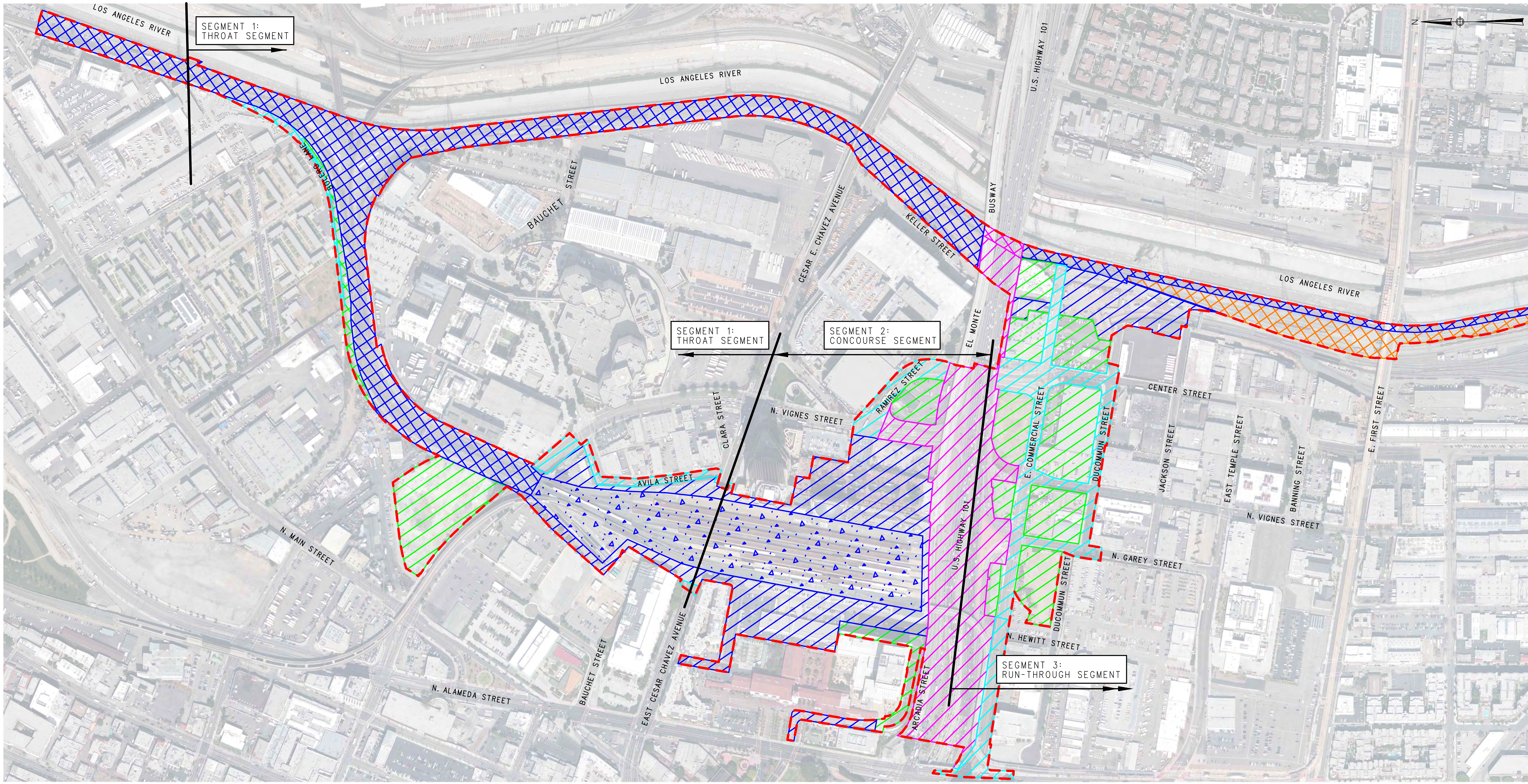

MATCH LINE
SEE EXHIBIT 2 OF 2

SUMMARY OF EXISTING IMPERVIOUS SURFACE WITHIN THE PROJECT FOOTPRINT LIMITS

SUBAREA	METRO R/W	BNSF R/W	PRIVATE PROPERTY R/W	LOCAL STREET R/W	CALTRANS R/W	TOTAL	IMPERVIOUS SURFACE	IMPERVIOUS SURFACE AREA (ACRES)
	(ACRES)						(%)	(ACRES)
////	18.22	-	17.42	9.95	15.53	61.12	91	55.62
· ▵ ·	14.42	-	-	-	-	14.42	66	9.52
XXXX	29.40	4.17	0.90	0.57	0.31	35.35	15	5.30
TOTAL	62.04	4.17	18.32	10.52	15.84	110.90		70.44

IMPERVIOUS SURFACE LEGEND:

- //// 91% IMPERVIOUS
- · ▵ · 66% IMPERVIOUS
- XXXX 15% IMPERVIOUS
- PROJECT FOOTPRINT

R/W LEGEND:

- METRO R/W
- BNSF R/W
- PRIVATE PROPERTY R/W
- LOCAL STREET R/W
- CALTRANS R/W

NOTE:

CITY AND STATE RIGHT OF WAY LINES SHOWN ARE SUBJECT TO CHANGE PENDING FURTHER INVESTIGATION

HDR | Metro

LINK UNION STATION
EXISTING IMPERVIOUS SURFACE EXHIBIT
SHEET 1 OF 2

SCALE: 1"=250'
DATE: 04-10-2018

11/14/2018 6:03:23 PM
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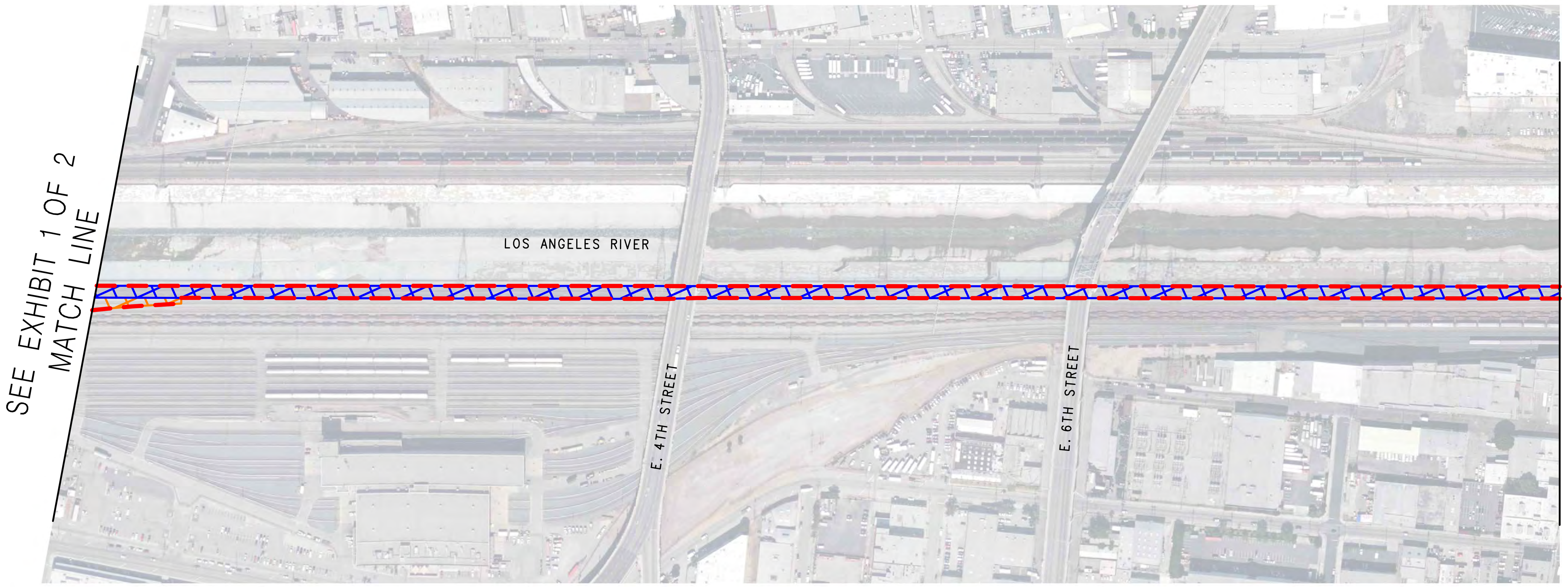

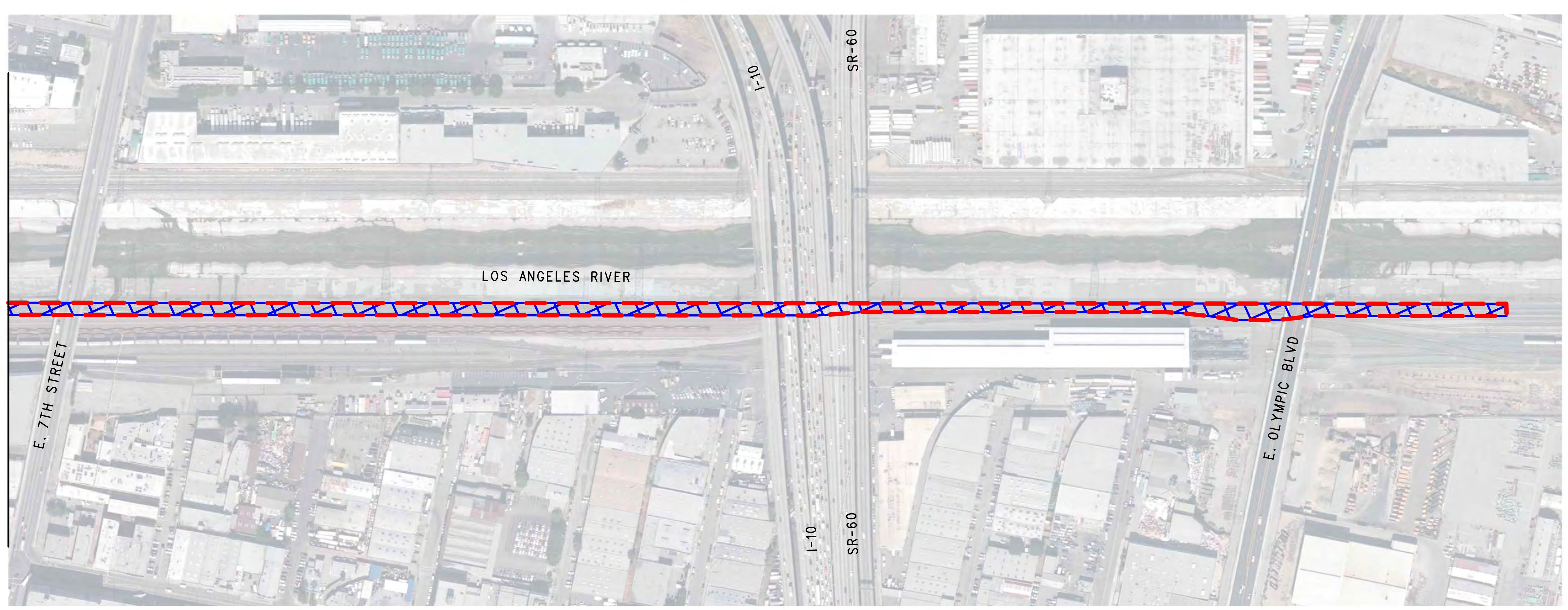

IMPERVIOUS SURFACE LEGEND:

- 15% IMPERVIOUS
- PROJECT FOOTPRINT

R/W LEGEND:

- METRO R/W
- BNSF R/W

NOTE:

CITY AND STATE RIGHT OF WAY LINES SHOWN ARE SUBJECT TO CHANGE PENDING FURTHER INVESTIGATION

HDR | Metro

LINK UNION STATION

EXISITNG IMPERVIOUS SURFACE EXHIBIT
SHEET 2 OF 2

SCALE: 1"=250'

DATE: 04-10-2018

DRAFT

MATCH LINE
SEE EXHIBIT 2 OF 2

SUMMARY OF PROPOSED IMPERVIOUS SURFACE
WITHIN THE PROJECT FOOTPRINT LIMITS

SUBAREA	METRO R/W	BNSF R/W	PRIVATE PROPERTY R/W	LOCAL STREET R/W	CALTRANS R/W	TOTAL	IMPERVIOUS SURFACE	IMPERVIOUS SURFACE AREA (ACRES)
				(ACRES)			(%)	(ACRES)
100% impervious	30.90	0.67	0.68	1.03	2.33	35.61	100	35.61
91% impervious	7.29	-	6.80	8.44	12.77	35.30	91	32.12
15% impervious	28.60	3.50	-	0.55	0.31	32.96	15	4.94
1% impervious	6.38	-	-	-	0.64	7.02	1	0.07
TOTAL	73.17	4.17	7.48	10.02	16.05	110.90		72.74

IMPERVIOUS SURFACE LEGEND:

- 100% IMPERVIOUS
- 91% IMPERVIOUS
- 15% IMPERVIOUS
- 1% IMPERVIOUS
- PROJECT FOOTPRINT

R/W LEGEND:

- METRO R/W
- BNSF R/W
- PRIVATE PROPERTY R/W
- LOCAL STREET R/W
- CALTRANS R/W

NOTE:
CITY AND STATE RIGHT OF WAY LINES SHOWN ARE SUBJECT TO CHANGE PENDING FURTHER INVESTIGATION

HDR | Metro

LINK UNION STATION
PROPOSED IMPERVIOUS SURFACE EXHIBIT
SHEET 1 OF 2

SCALE: 1"=250'
DATE: 04-10-2018

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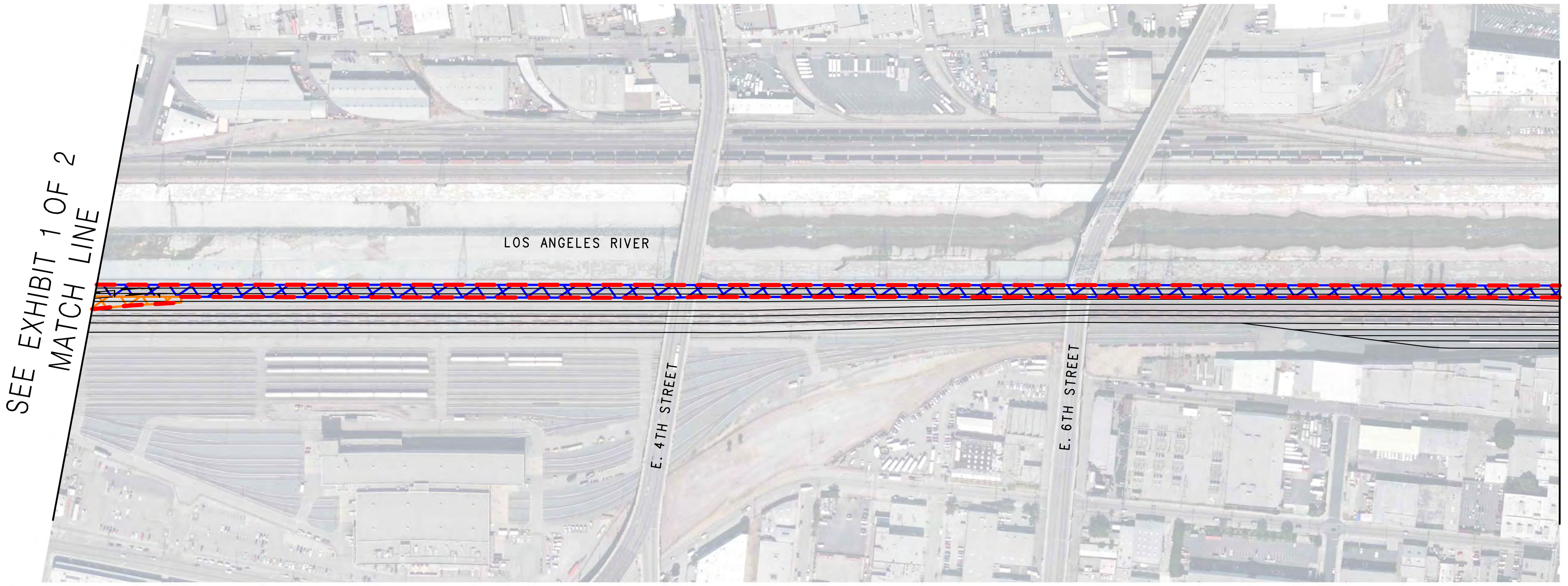
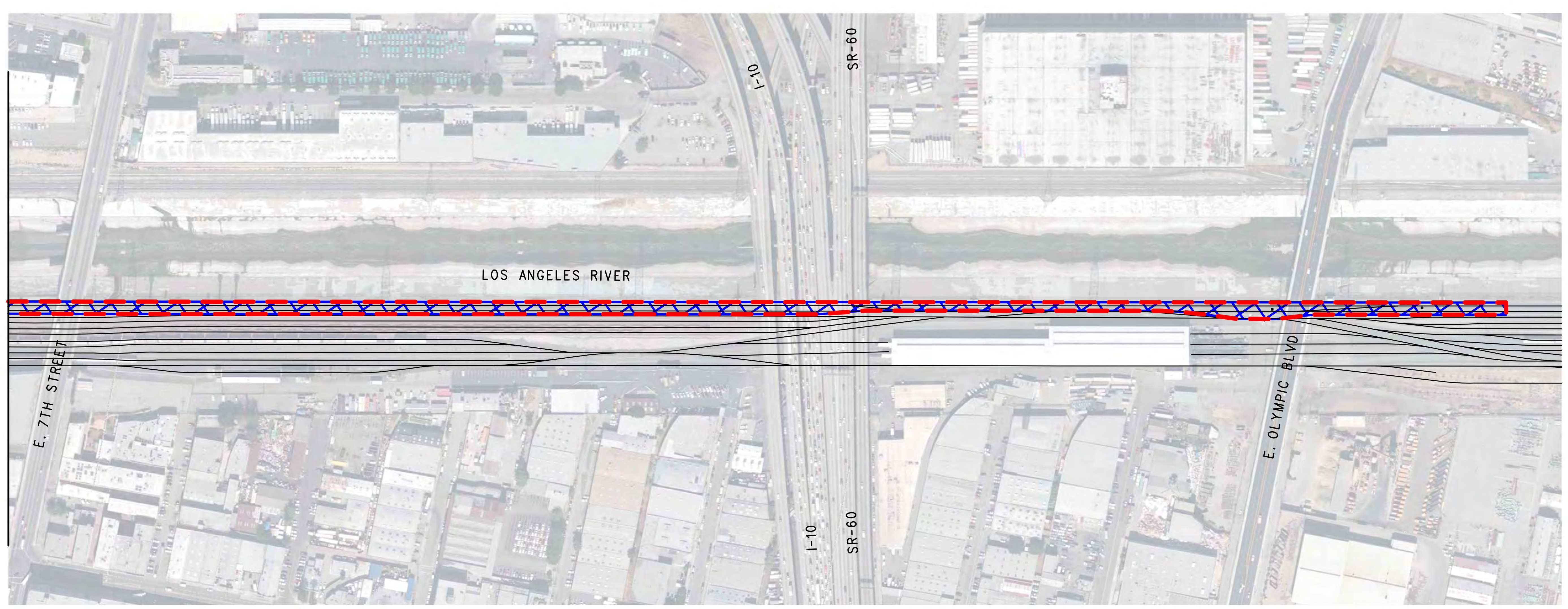
SEE EXHIBIT 1 OF 2
MATCH LINE



MATCH LINE
SEE BELOW LEFT

SEE ABOVE RIGHT
MATCH LINE



IMPERVIOUS SURFACE LEGEND:

- 15% IMPERVIOUS
- PROJECT FOOTPRINT

R/W LEGEND:

- METRO R/W
- BNSF R/W

NOTE:

CITY AND STATE RIGHT OF WAY LINES SHOWN ARE SUBJECT TO CHANGE PENDING FURTHER INVESTIGATION

HDR	Metro	LINK UNION STATION PROPOSED IMPERVIOUS SURFACE EXHIBIT SHEET 2 OF 2	SCALE: 1"=250' DATE: 04-10-2018

Appendix B:
Stormwater Quantity Calculations

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Peak Flow Hydrologic Analysis

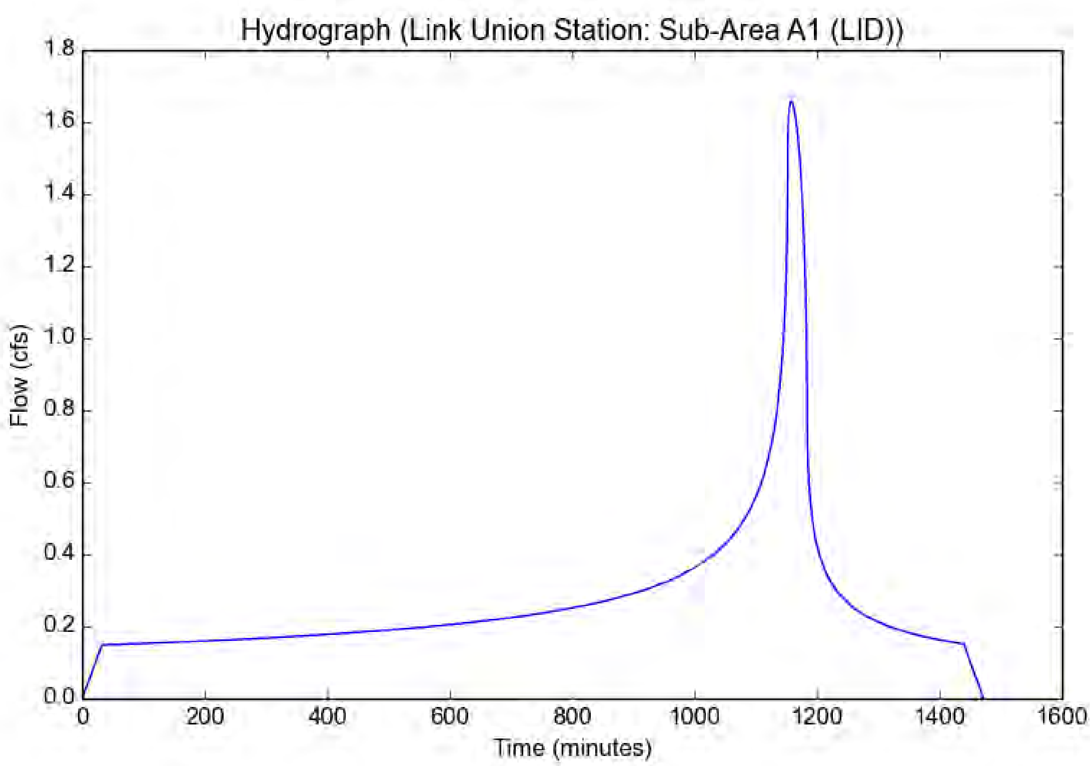
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A1 (LID)
Area (ac)	7.38
Flow Path Length (ft)	1000.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2493
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	32.0
Clear Peak Flow Rate (cfs)	1.6561
Burned Peak Flow Rate (cfs)	1.6561
24-Hr Clear Runoff Volume (ac-ft)	0.5489
24-Hr Clear Runoff Volume (cu-ft)	23911.5128



Peak Flow Hydrologic Analysis

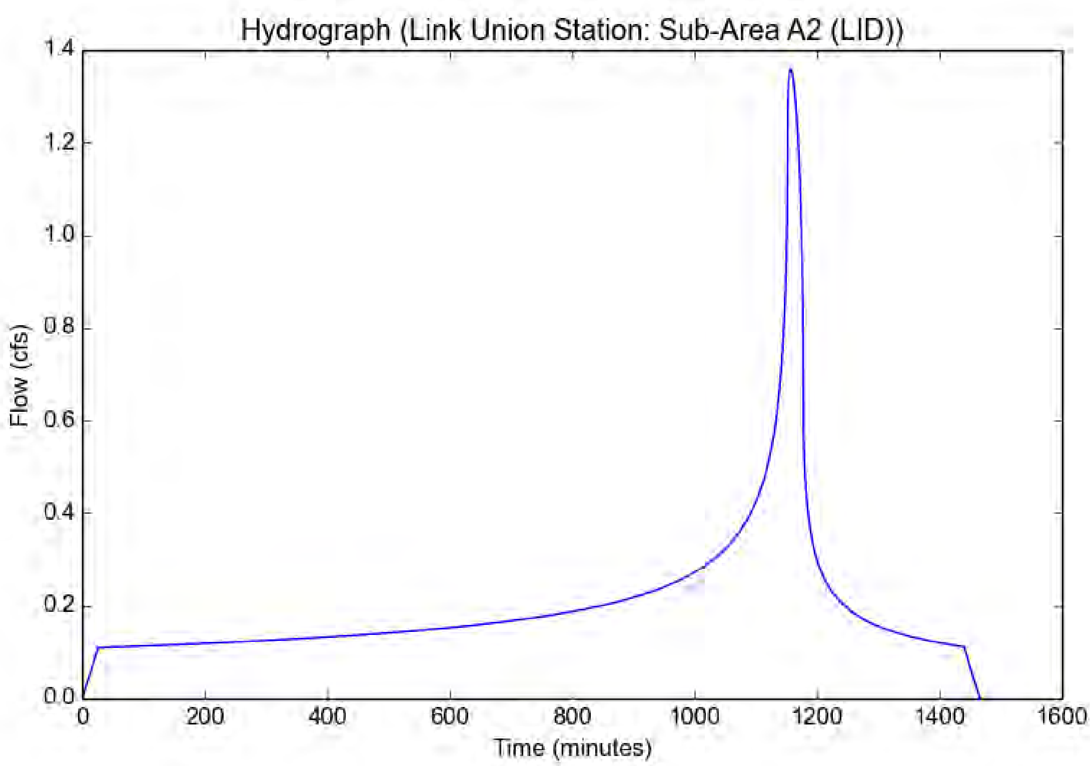
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A2 (LID)
Area (ac)	5.49
Flow Path Length (ft)	700.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2749
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	26.0
Clear Peak Flow Rate (cfs)	1.3583
Burned Peak Flow Rate (cfs)	1.3583
24-Hr Clear Runoff Volume (ac-ft)	0.4084
24-Hr Clear Runoff Volume (cu-ft)	17787.753



Peak Flow Hydrologic Analysis

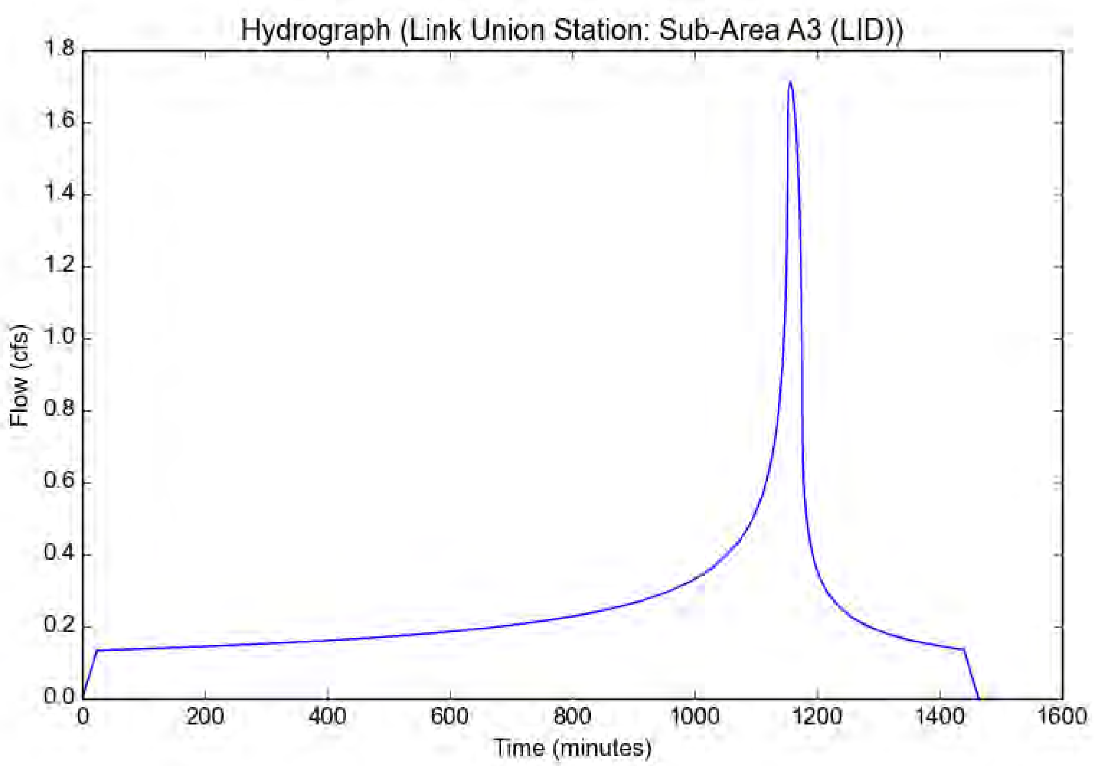
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A3 (LID)
Area (ac)	6.66
Flow Path Length (ft)	650.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	1.7109
Burned Peak Flow Rate (cfs)	1.7109
24-Hr Clear Runoff Volume (ac-ft)	0.4954
24-Hr Clear Runoff Volume (cu-ft)	21578.5579



Peak Flow Hydrologic Analysis

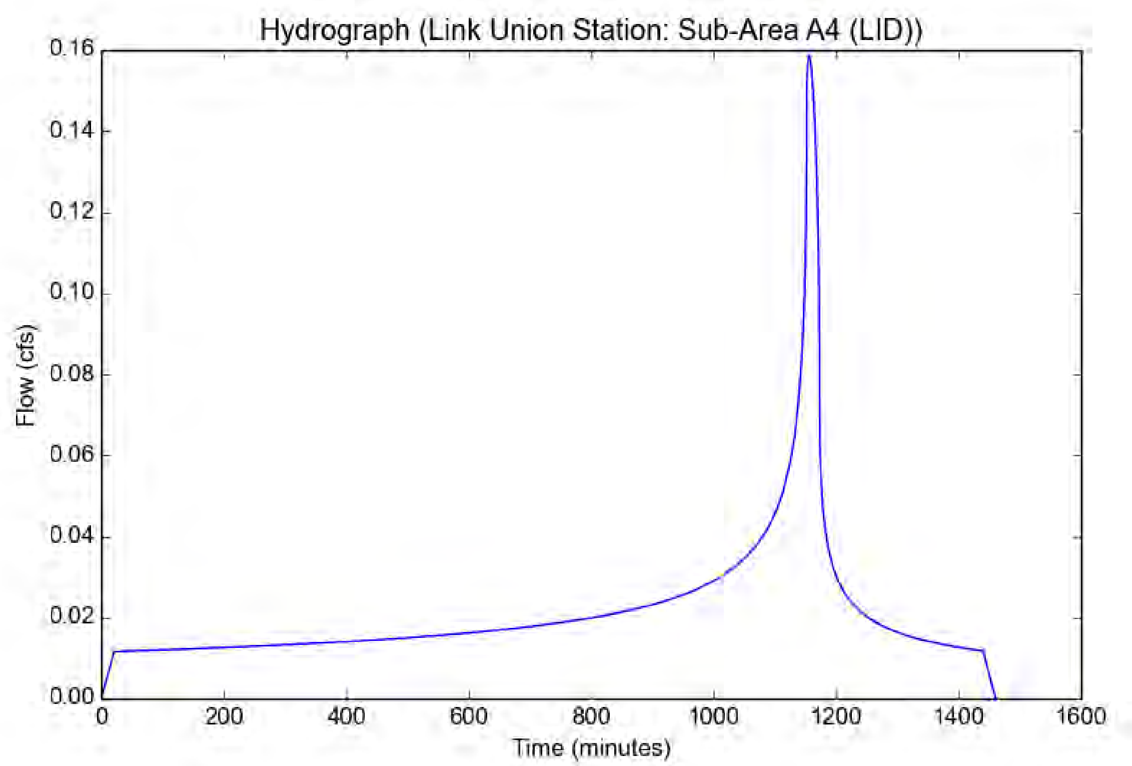
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A4 (LID)
Area (ac)	0.58
Flow Path Length (ft)	500.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.3039
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	21.0
Clear Peak Flow Rate (cfs)	0.1587
Burned Peak Flow Rate (cfs)	0.1587
24-Hr Clear Runoff Volume (ac-ft)	0.0431
24-Hr Clear Runoff Volume (cu-ft)	1879.2105



Peak Flow Hydrologic Analysis

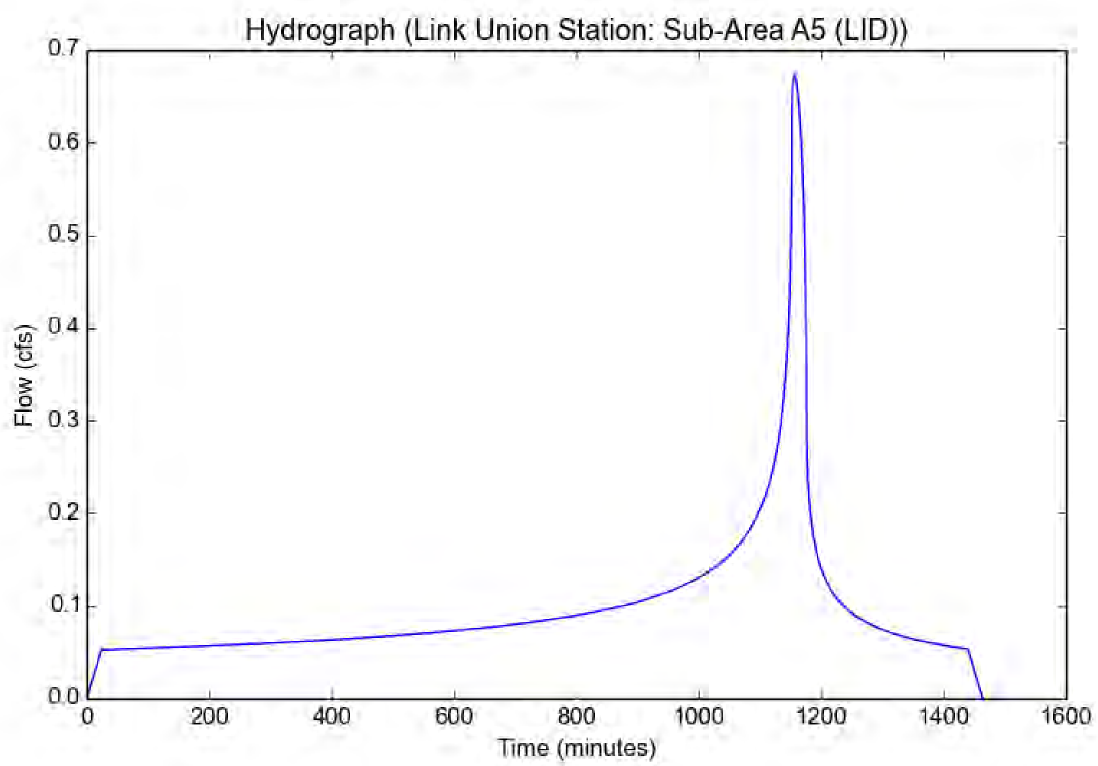
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A5 (LID)
Area (ac)	2.62
Flow Path Length (ft)	620.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.6731
Burned Peak Flow Rate (cfs)	0.6731
24-Hr Clear Runoff Volume (ac-ft)	0.1949
24-Hr Clear Runoff Volume (cu-ft)	8488.8621



Peak Flow Hydrologic Analysis

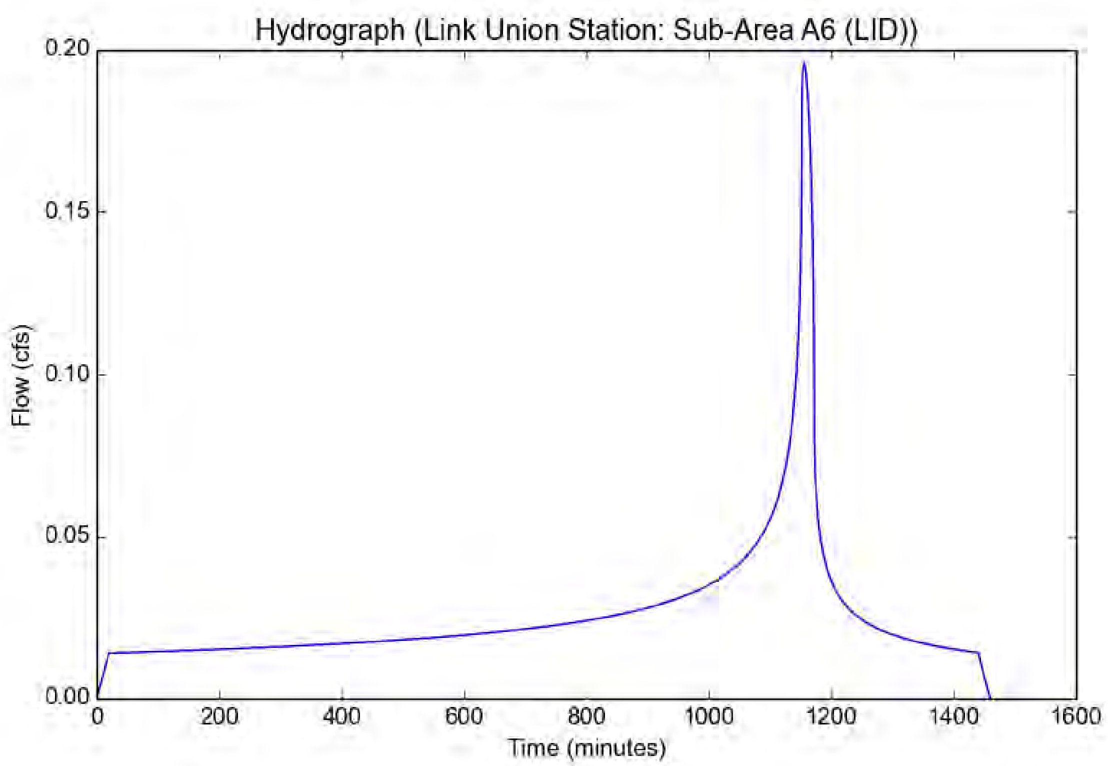
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A6 (LID)
Area (ac)	0.7
Flow Path Length (ft)	480.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.311
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	20.0
Clear Peak Flow Rate (cfs)	0.1959
Burned Peak Flow Rate (cfs)	0.1959
24-Hr Clear Runoff Volume (ac-ft)	0.0521
24-Hr Clear Runoff Volume (cu-ft)	2268.0115



Peak Flow Hydrologic Analysis

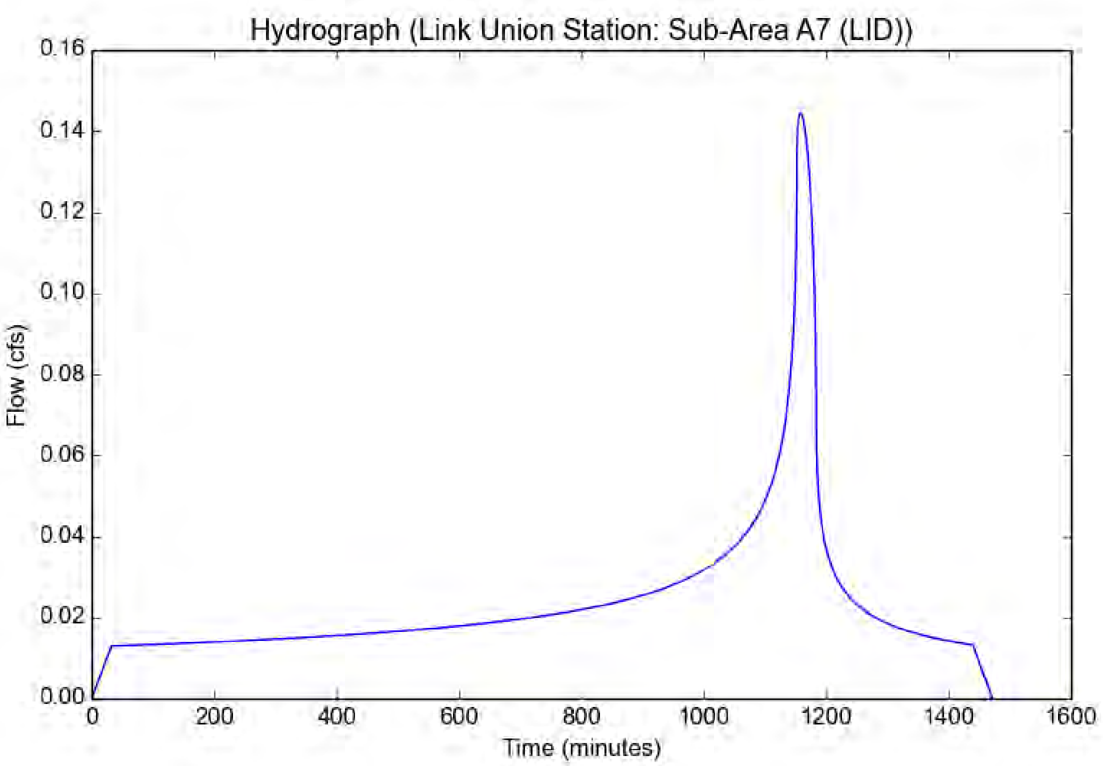
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A7 (LID)
Area (ac)	0.7
Flow Path Length (ft)	910.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.91
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2493
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.828
Time of Concentration (min)	32.0
Clear Peak Flow Rate (cfs)	0.1445
Burned Peak Flow Rate (cfs)	0.1445
24-Hr Clear Runoff Volume (ac-ft)	0.0479
24-Hr Clear Runoff Volume (cu-ft)	2086.5873



Peak Flow Hydrologic Analysis

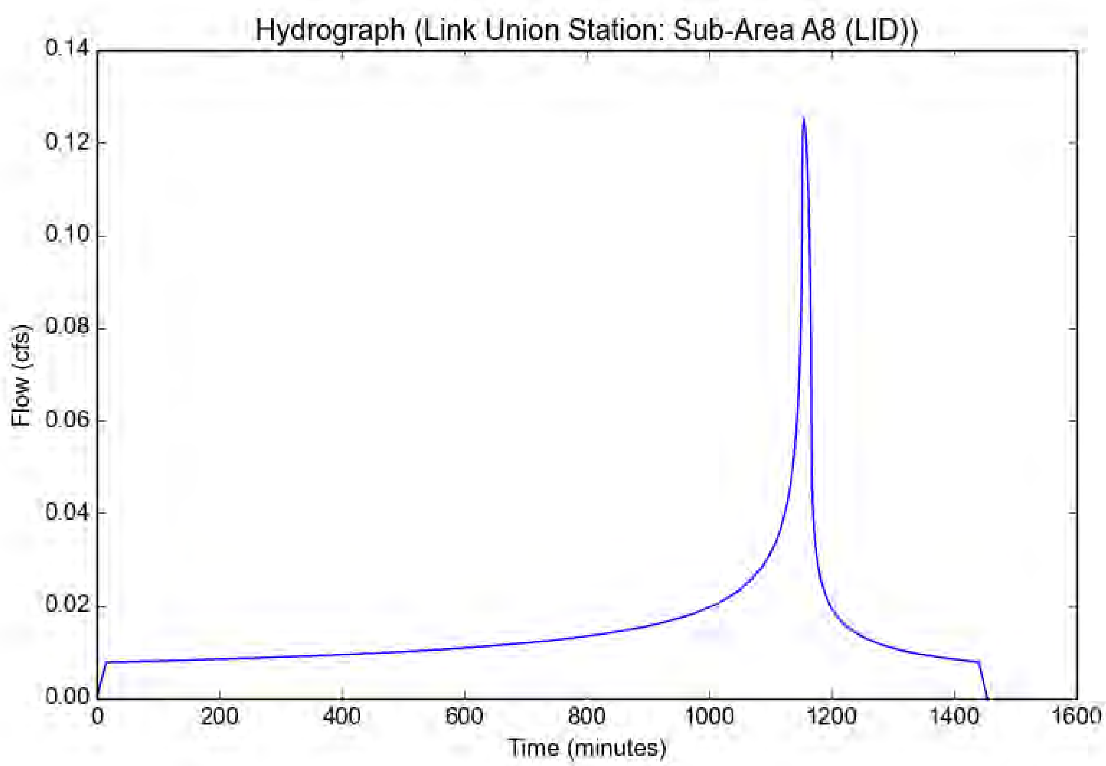
Version: HydroCalc 1.0.2

Input Parameters

Project Name	Link Union Station
Subarea ID	Sub-Area A8 (LID)
Area (ac)	0.39
Flow Path Length (ft)	300.0
Flow Path Slope (vft/hft)	0.02
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	1.0
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.356
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.9
Time of Concentration (min)	15.0
Clear Peak Flow Rate (cfs)	0.125
Burned Peak Flow Rate (cfs)	0.125
24-Hr Clear Runoff Volume (ac-ft)	0.029
24-Hr Clear Runoff Volume (cu-ft)	1263.6036



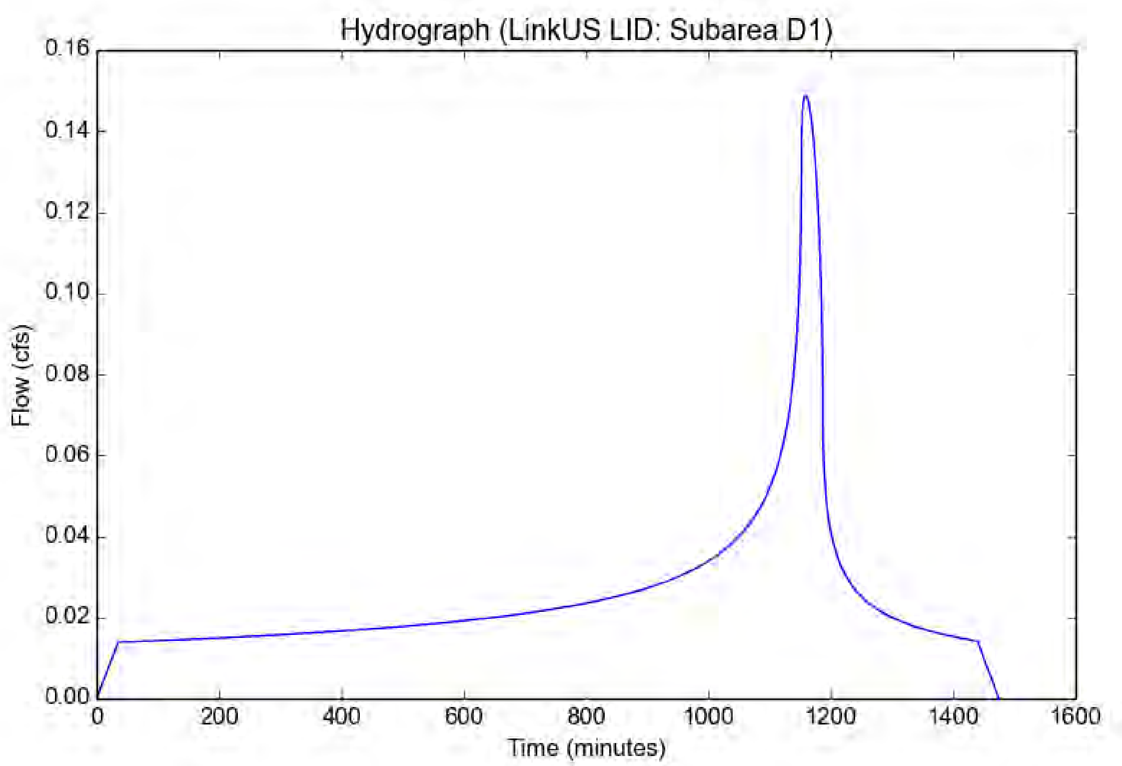
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea D1
Area (ac)	1.17
Flow Path Length (ft)	390.0
Flow Path Slope (vft/hft)	0.003
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.54
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2391
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.532
Time of Concentration (min)	35.0
Clear Peak Flow Rate (cfs)	0.1488
Burned Peak Flow Rate (cfs)	0.1488
24-Hr Clear Runoff Volume (ac-ft)	0.0514
24-Hr Clear Runoff Volume (cu-ft)	2240.8191



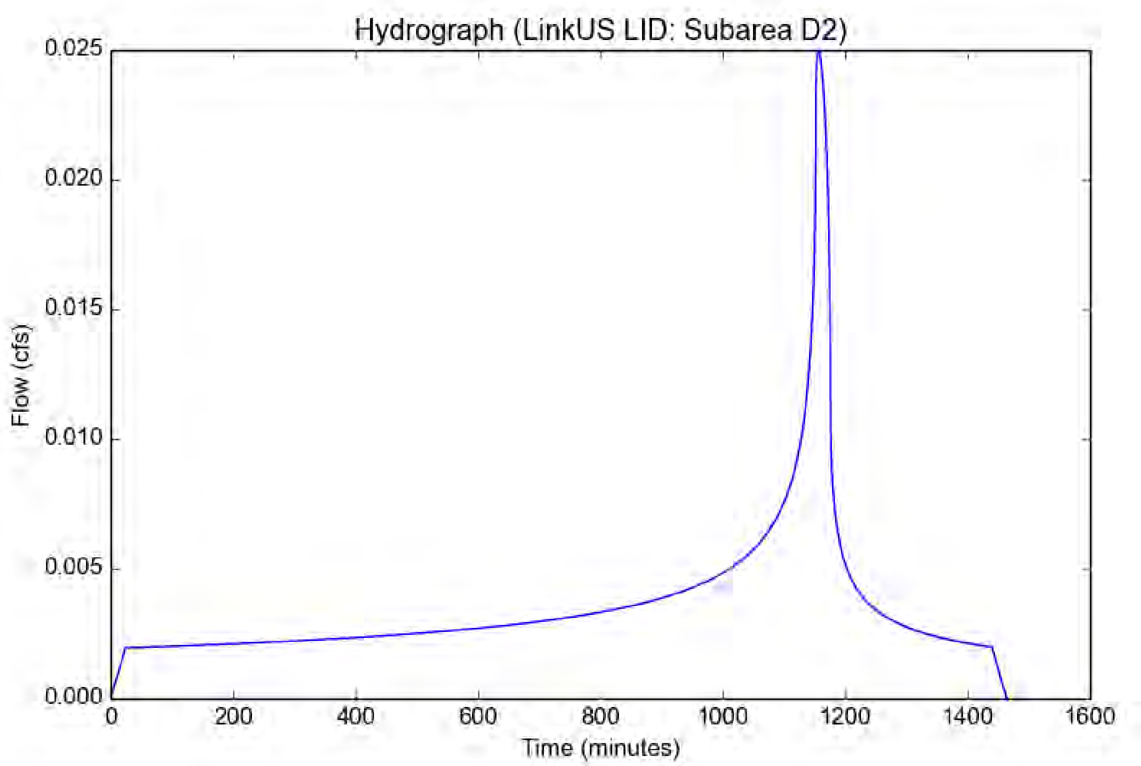
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea D2
Area (ac)	0.81
Flow Path Length (ft)	125.0
Flow Path Slope (vft/hft)	0.2
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.01
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.108
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.025
Burned Peak Flow Rate (cfs)	0.025
24-Hr Clear Runoff Volume (ac-ft)	0.0072
24-Hr Clear Runoff Volume (cu-ft)	314.9303



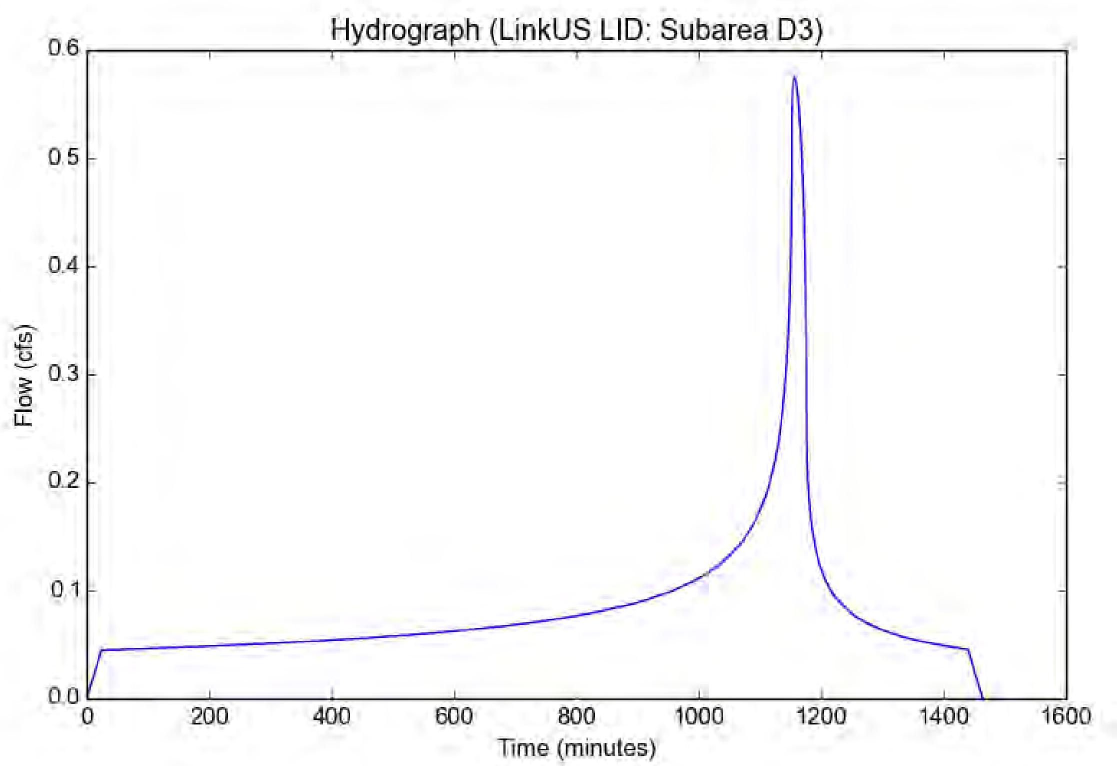
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea D3
Area (ac)	2.43
Flow Path Length (ft)	388.0
Flow Path Slope (vft/hft)	0.005
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.91
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.828
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.5743
Burned Peak Flow Rate (cfs)	0.5743
24-Hr Clear Runoff Volume (ac-ft)	0.1663
24-Hr Clear Runoff Volume (cu-ft)	7243.397



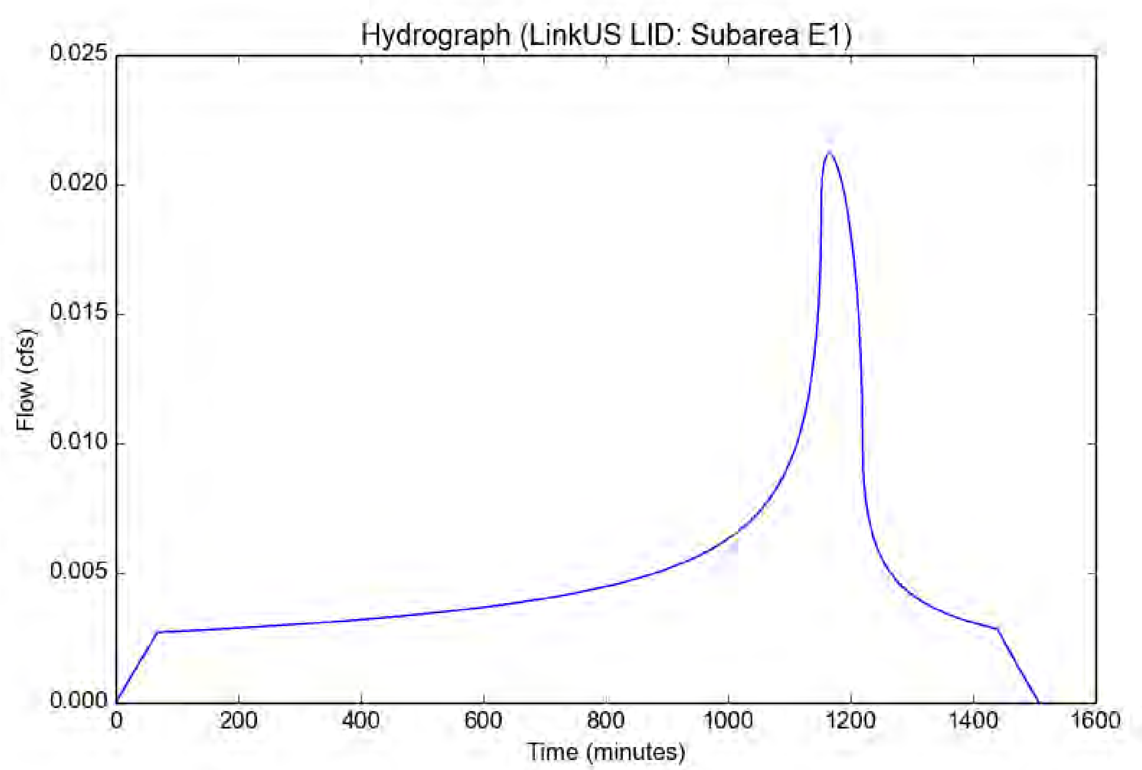
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea E1
Area (ac)	1.12
Flow Path Length (ft)	295.0
Flow Path Slope (vft/hft)	0.013
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.01
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.175
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.108
Time of Concentration (min)	68.0
Clear Peak Flow Rate (cfs)	0.0212
Burned Peak Flow Rate (cfs)	0.0212
24-Hr Clear Runoff Volume (ac-ft)	0.01
24-Hr Clear Runoff Volume (cu-ft)	435.4823



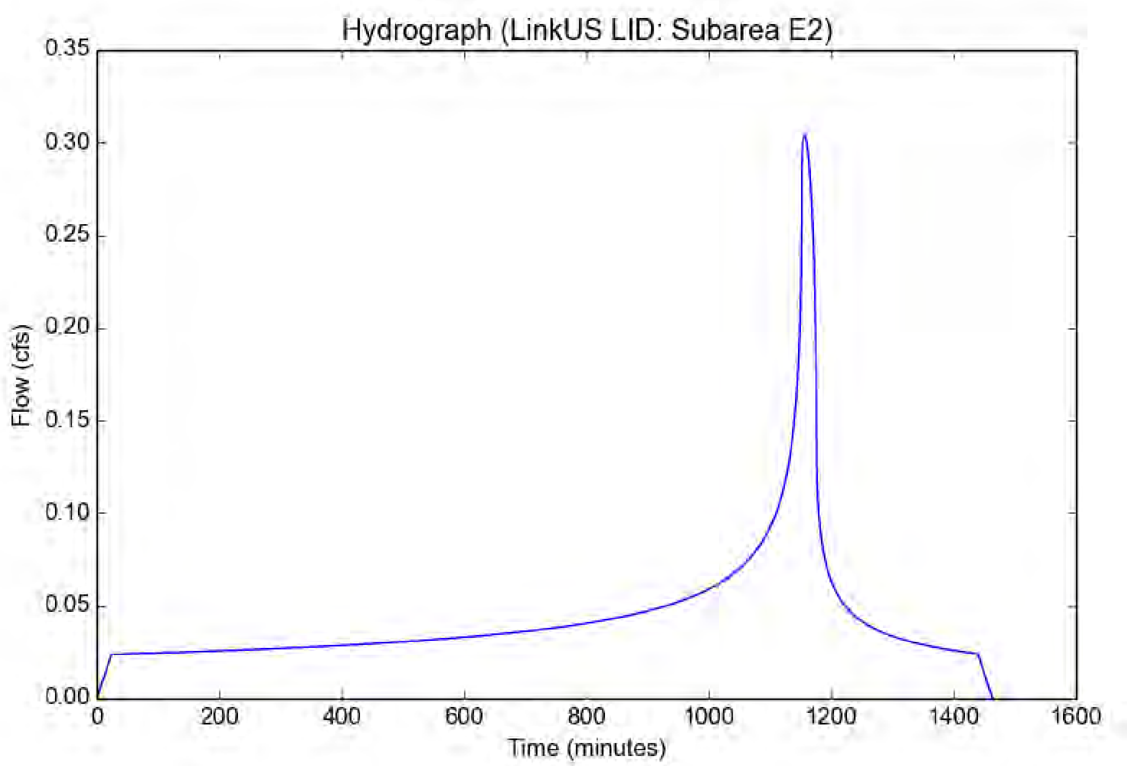
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea E2
Area (ac)	1.79
Flow Path Length (ft)	439.0
Flow Path Slope (vft/hft)	0.026
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.62
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.596
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.3045
Burned Peak Flow Rate (cfs)	0.3045
24-Hr Clear Runoff Volume (ac-ft)	0.0882
24-Hr Clear Runoff Volume (cu-ft)	3840.6521



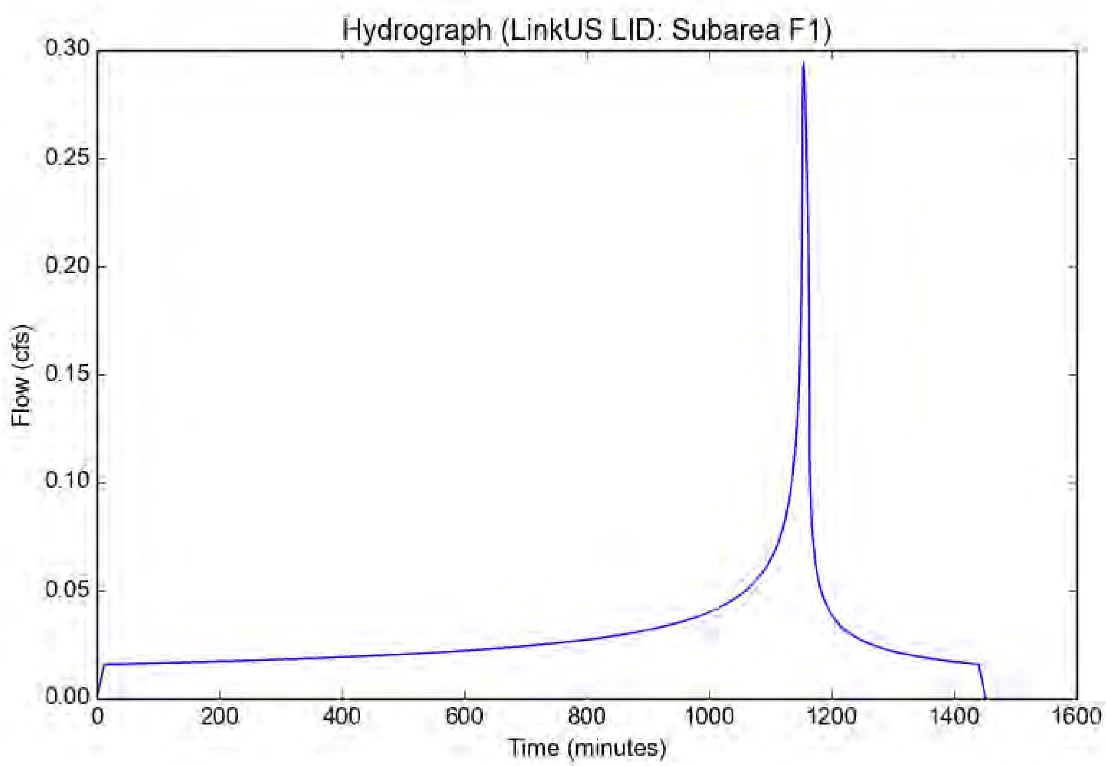
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea F1
Area (ac)	1.49
Flow Path Length (ft)	140.0
Flow Path Slope (vft/hft)	0.038
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.47
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.3954
Undeveloped Runoff Coefficient (Cu)	0.1436
Developed Runoff Coefficient (Cd)	0.4991
Time of Concentration (min)	12.0
Clear Peak Flow Rate (cfs)	0.294
Burned Peak Flow Rate (cfs)	0.294
24-Hr Clear Runoff Volume (ac-ft)	0.0587
24-Hr Clear Runoff Volume (cu-ft)	2556.8011



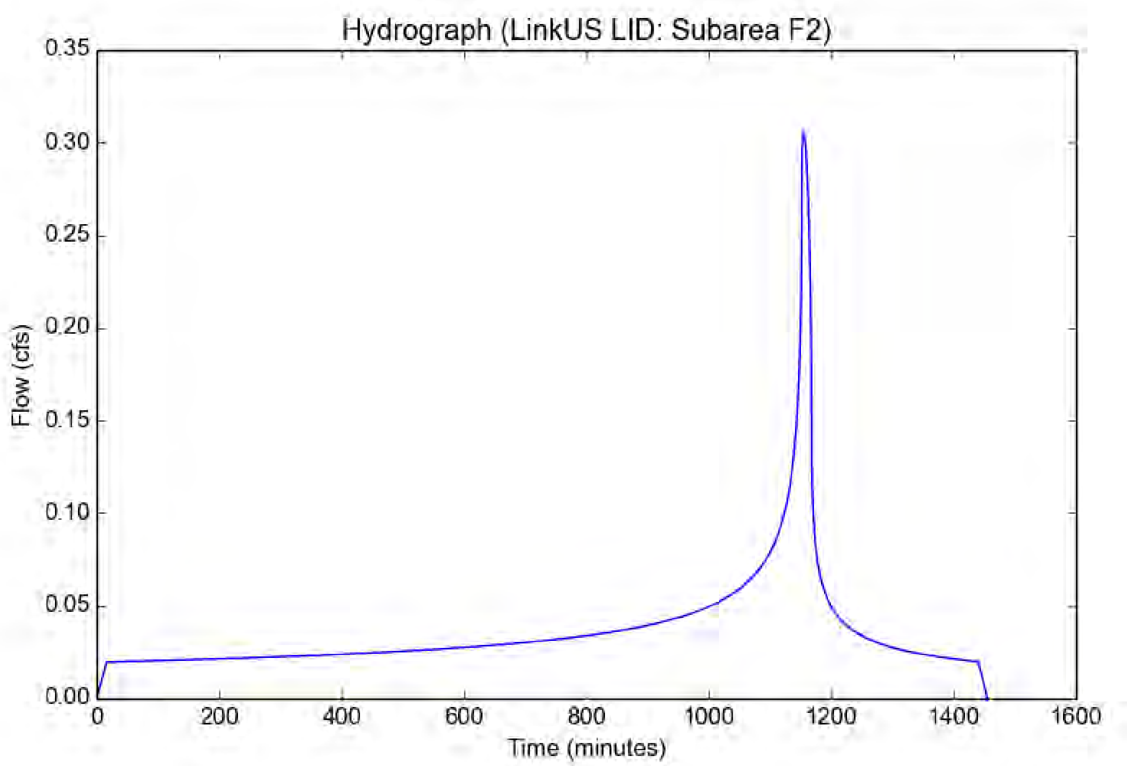
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea F2
Area (ac)	1.07
Flow Path Length (ft)	214.0
Flow Path Slope (vft/hft)	0.006
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.91
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.3454
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.828
Time of Concentration (min)	16.0
Clear Peak Flow Rate (cfs)	0.306
Burned Peak Flow Rate (cfs)	0.306
24-Hr Clear Runoff Volume (ac-ft)	0.0732
24-Hr Clear Runoff Volume (cu-ft)	3189.4663



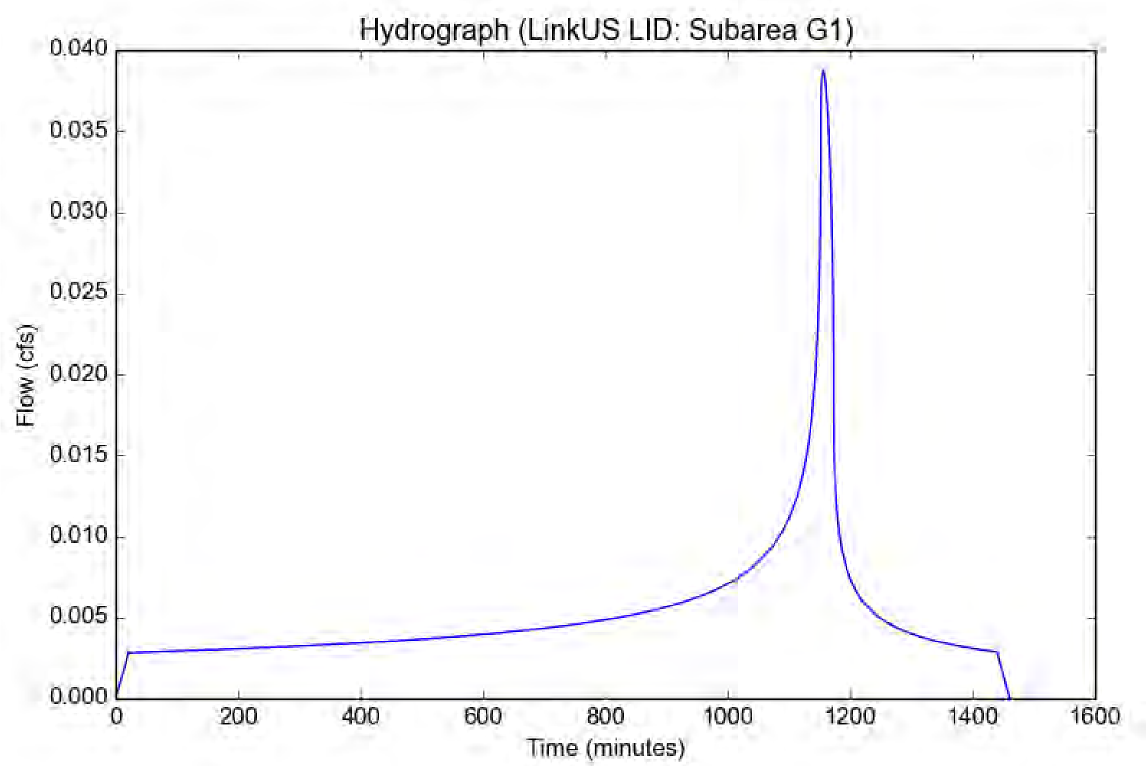
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea G1
Area (ac)	0.65
Flow Path Length (ft)	111.0
Flow Path Slope (vft/hft)	0.029
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.12
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.3039
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.196
Time of Concentration (min)	21.0
Clear Peak Flow Rate (cfs)	0.0387
Burned Peak Flow Rate (cfs)	0.0387
24-Hr Clear Runoff Volume (ac-ft)	0.0105
24-Hr Clear Runoff Volume (cu-ft)	458.6426



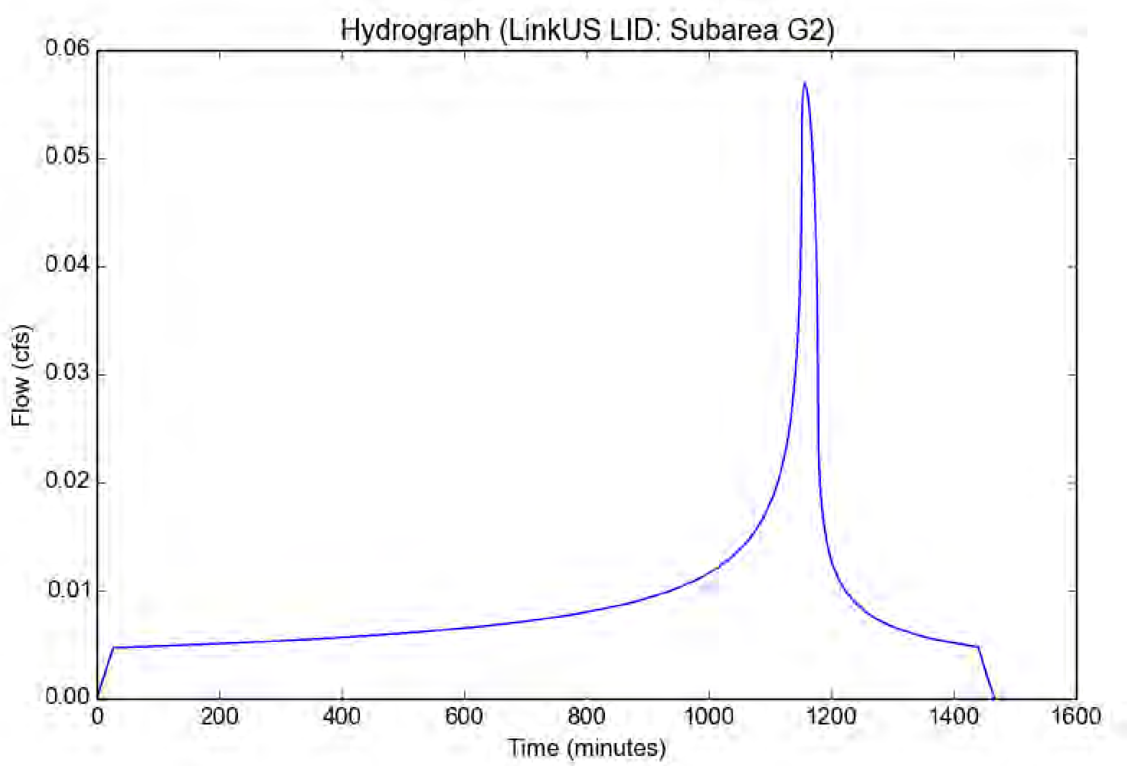
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea G2
Area (ac)	1.95
Flow Path Length (ft)	140.0
Flow Path Slope (vft/hft)	0.152
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.01
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2701
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.108
Time of Concentration (min)	27.0
Clear Peak Flow Rate (cfs)	0.0569
Burned Peak Flow Rate (cfs)	0.0569
24-Hr Clear Runoff Volume (ac-ft)	0.0174
24-Hr Clear Runoff Volume (cu-ft)	758.167



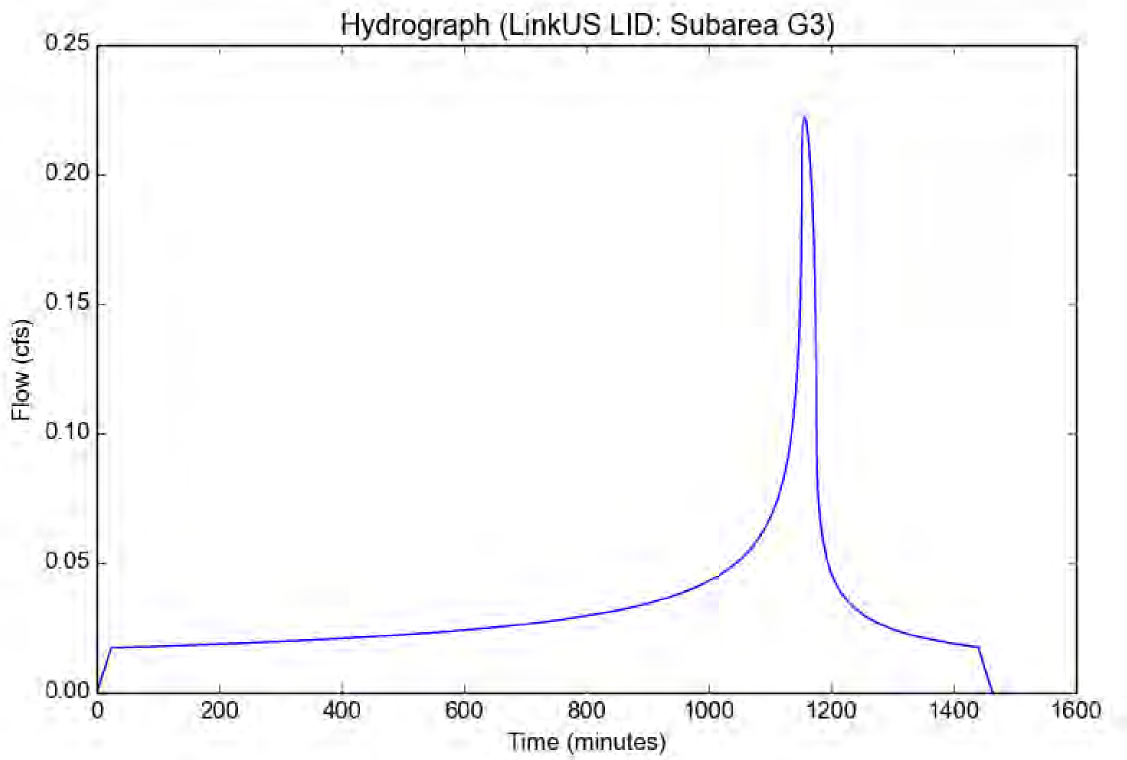
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea G3
Area (ac)	0.94
Flow Path Length (ft)	383.0
Flow Path Slope (vft/hft)	0.005
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.91
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2854
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.828
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.2222
Burned Peak Flow Rate (cfs)	0.2222
24-Hr Clear Runoff Volume (ac-ft)	0.0643
24-Hr Clear Runoff Volume (cu-ft)	2801.9725



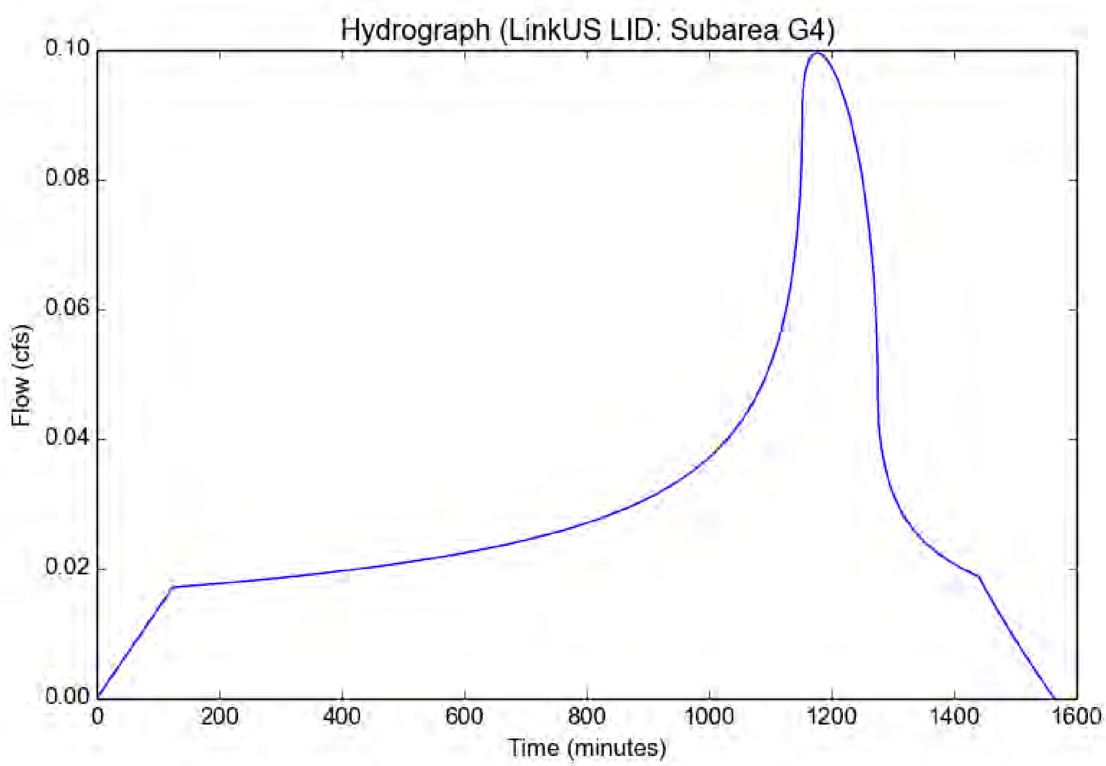
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea G4
Area (ac)	3.43
Flow Path Length (ft)	1362.0
Flow Path Slope (vft/hft)	0.007
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.15
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1319
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.22
Time of Concentration (min)	124.0
Clear Peak Flow Rate (cfs)	0.0995
Burned Peak Flow Rate (cfs)	0.0995
24-Hr Clear Runoff Volume (ac-ft)	0.0624
24-Hr Clear Runoff Volume (cu-ft)	2717.1276



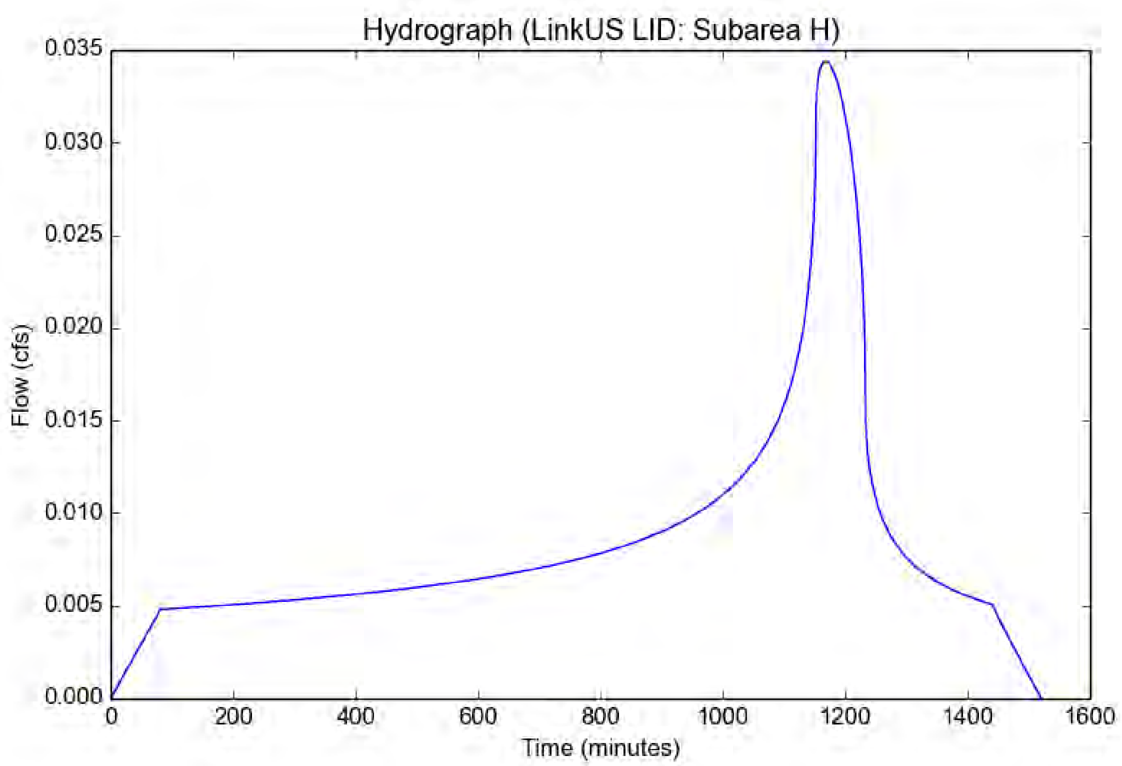
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea H
Area (ac)	0.97
Flow Path Length (ft)	1045.0
Flow Path Slope (vft/hft)	0.03
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.15
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1612
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.22
Time of Concentration (min)	81.0
Clear Peak Flow Rate (cfs)	0.0344
Burned Peak Flow Rate (cfs)	0.0344
24-Hr Clear Runoff Volume (ac-ft)	0.0176
24-Hr Clear Runoff Volume (cu-ft)	768.3065



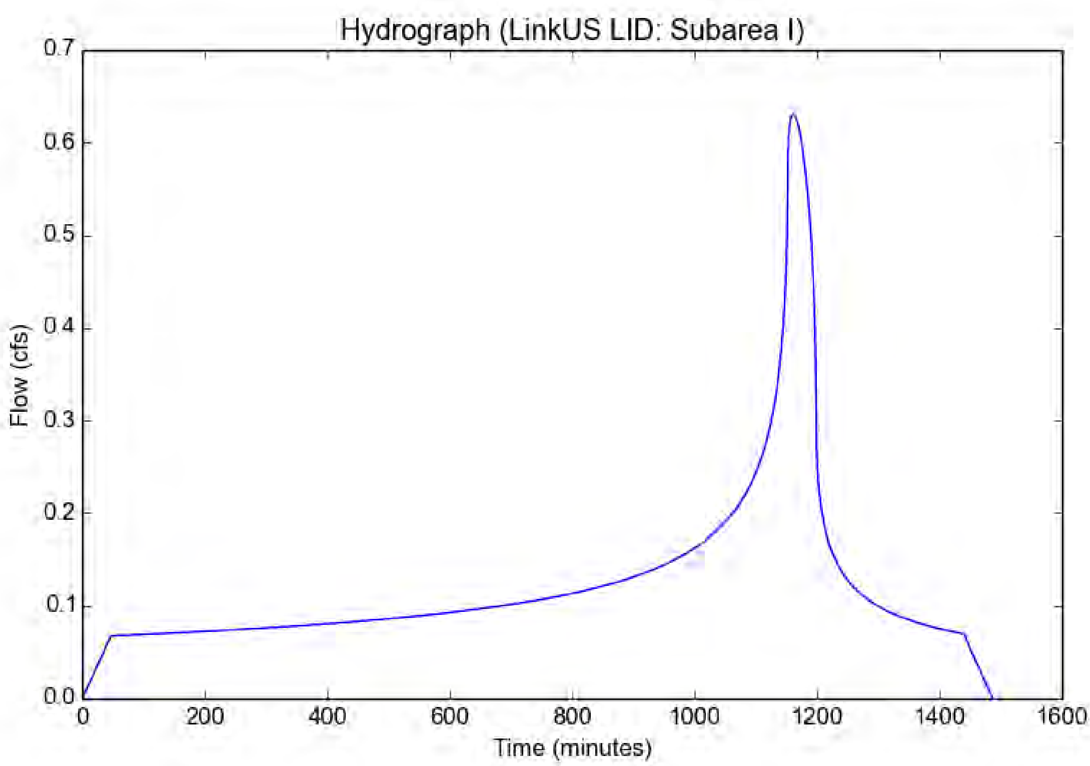
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea I
Area (ac)	5.01
Flow Path Length (ft)	649.0
Flow Path Slope (vft/hft)	0.0023
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.63
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2081
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.604
Time of Concentration (min)	47.0
Clear Peak Flow Rate (cfs)	0.6298
Burned Peak Flow Rate (cfs)	0.6298
24-Hr Clear Runoff Volume (ac-ft)	0.2501
24-Hr Clear Runoff Volume (cu-ft)	10894.0544



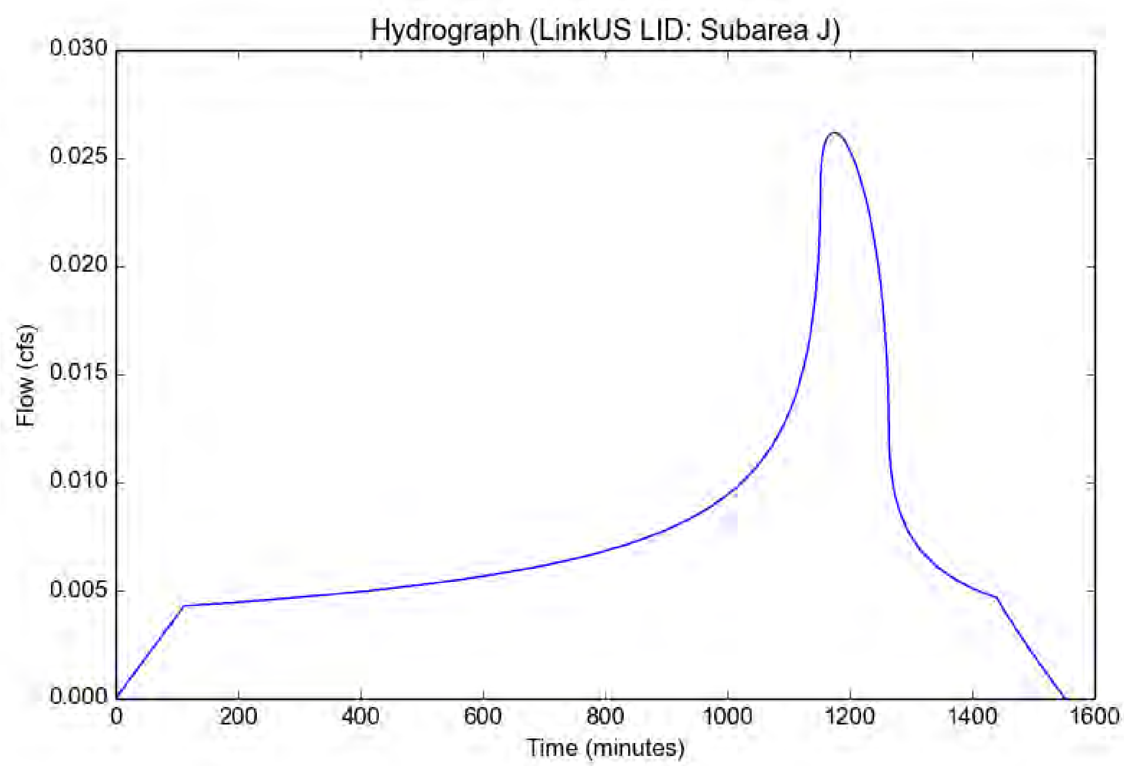
Peak Flow Hydrologic Analysis

Input Parameters

Project Name	LinkUS LID
Subarea ID	Subarea J
Area (ac)	0.86
Flow Path Length (ft)	850.0
Flow Path Slope (vft/hft)	0.0023
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.15
Soil Type	6
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.1384
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.22
Time of Concentration (min)	112.0
Clear Peak Flow Rate (cfs)	0.0262
Burned Peak Flow Rate (cfs)	0.0262
24-Hr Clear Runoff Volume (ac-ft)	0.0156
24-Hr Clear Runoff Volume (cu-ft)	681.2351



Appendix C:
Low Impact Development Exhibits

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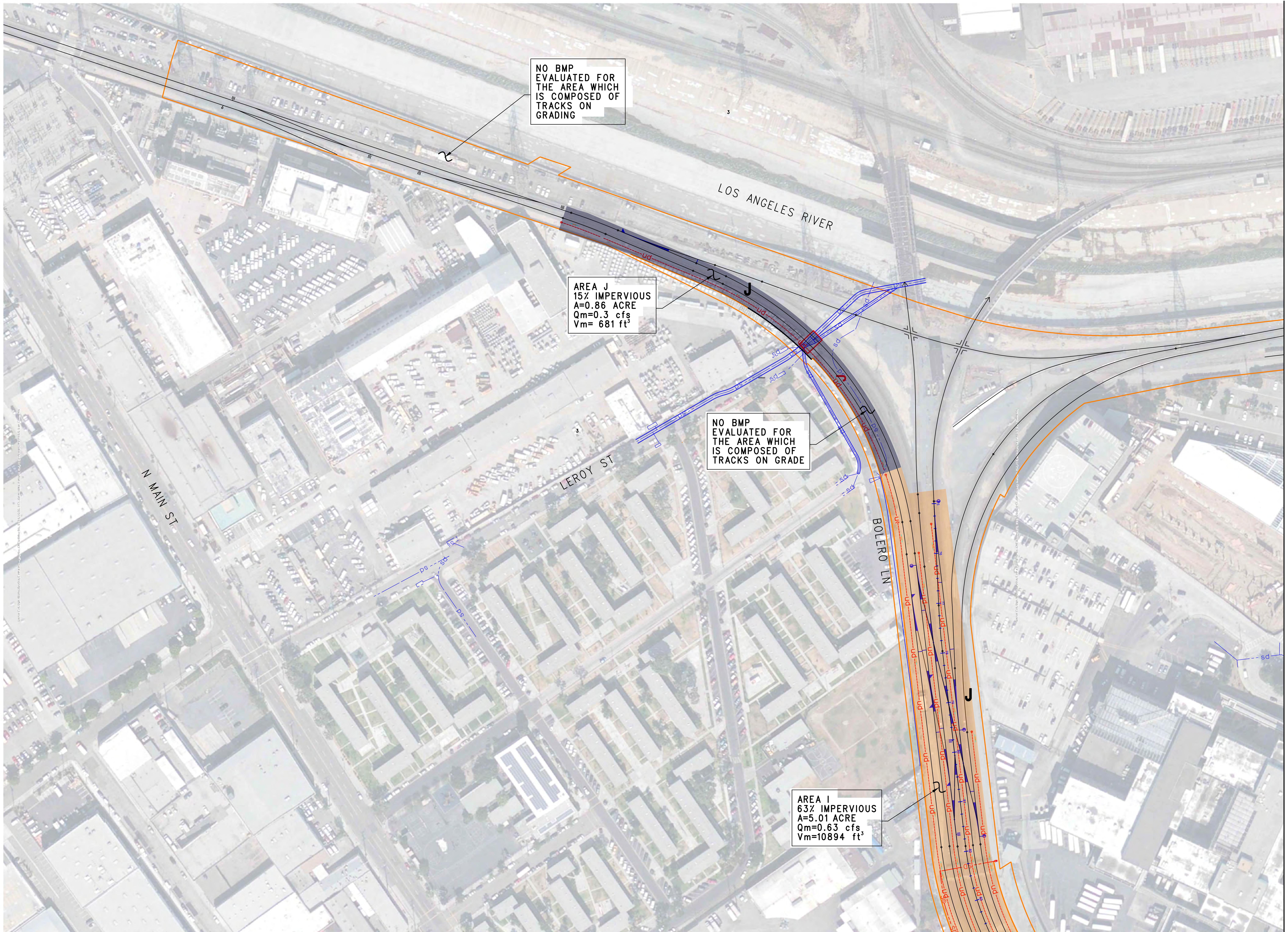


MATCH LINE
SEE EXHIBIT 3 OF 7

LEGEND:

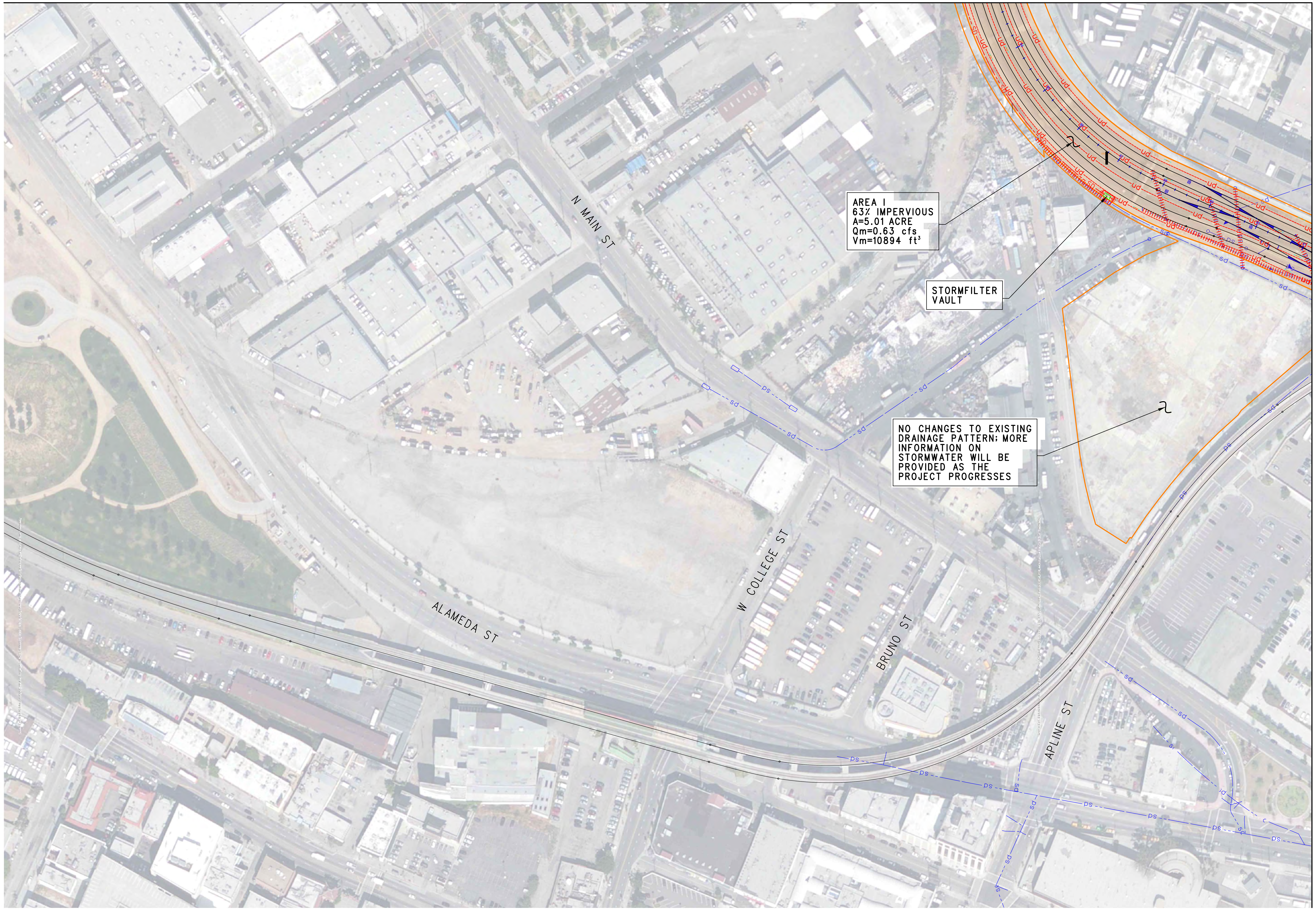
- AREA I
- AREA J
- EXISTING STORM DRAIN
- DRAINAGE SUB-AREA BOUNDARY
- PROJECT FOOTPRINT
- TRACK UNDERDRAIN

MATCH LINE
SEE EXHIBIT 2 OF 7

DRAFT

HDR	Metro	LINK UNION STATION PRELIMINARY LID EXHIBIT SHEET 1 OF 7	SCALE: 1"=100' DATE: 04-13-2018

SEE EXHIBIT 1 OF 7
MATCH LINE



MATCH LINE
SEE EXHIBIT 4 OF 7

LEGEND:

- AREA I
- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- DRAINAGE SUB-AREA BOUNDARY
- PROJECT FOOPRINT
- STORMFILTER VAULT
- TRACK UNDERDRAIN

HDR | Metro

LINK UNION STATION

PRELIMINARY LID EXHIBIT
SHEET 2 OF 7

SCALE: 1"=100'
DATE: 04-13-2018

11/14/2018 5:44:32 PM
c:\pwworking\sac\d0852905\SUSMP2.dgn
c:\Users\hlo\My Plots\011829\000000000232098\PlotStamp.tbl
c:\pwworking\sac\d0603326\LUS-Exhibit-FW-CLR.pltcfg

SEE EXHIBIT 1 OF 7
MATCH LINE

MATCH LINE
SEE EXHIBIT 5 OF 7

LEGEND:

(purple fill)	AREA G (G4)
—sd—	EXISTING STORM DRAIN
- - -	DRAINAGE SUB-AREA BOUNDARY
——	PROJECT FOOTPRINT
—ud—	TRACK UNDERDRAIN

MATCH LINE
SEE EXHIBIT 4 OF 7

HDR | Metro

LINK UNION STATION

PRELIMINARY LID EXHIBIT
SHEET 3 OF 7

SCALE: 1"=100'
DATE: 04-13-2018

11/14/2018 5:56:43 PM
c:\pwworking\sac\d0852905\SUSMP3.dgn
C:\Users\hlai\My Plots\011829\000000002332098\PlotStamp.tbl
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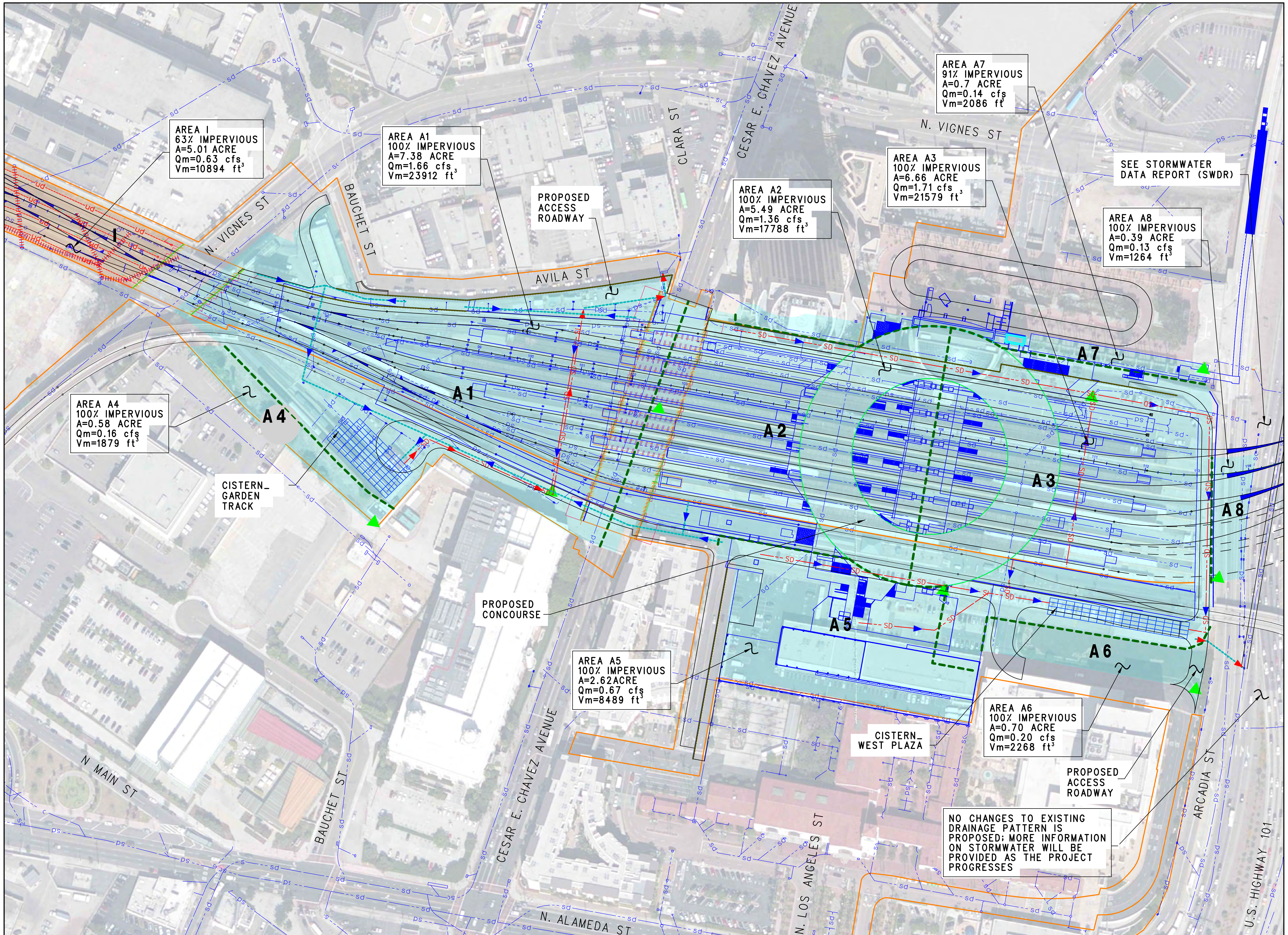
SEE EXHIBIT 3 OF 7
MATCH LINE

SEE EXHIBIT 2 OF 7
MATCH LINE



MATCH LINE
SEE EXHIBIT 5 OF 7

LEGEND:

(orange fill)	AREA I
(cyan fill)	AREA A (A1, A2, A3, A4, A5, A6, A7, A8)
---SD---	PROPOSED STORM DRAIN
---sd---	EXISTING STORM DRAIN
- - -	DRAINAGE SUB-AREA BOUNDARY
(grid)	CISTERN
—	PROJECT FOOTPRINT
---ud---	TRACK UNDERDRAIN

11/16/2018 3:57:15 PM
c:\pwworking\sac\d0852905\SUSMP4.dgn
pw:\\pwappsac01:California_Sacramento\Documents\01829\00000000232098\13.00_CAD_BIM\13.01_CAD_Data\PRJ_CAD_STD\PLOTDRV\PlotStamp.tbl
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DRAFT

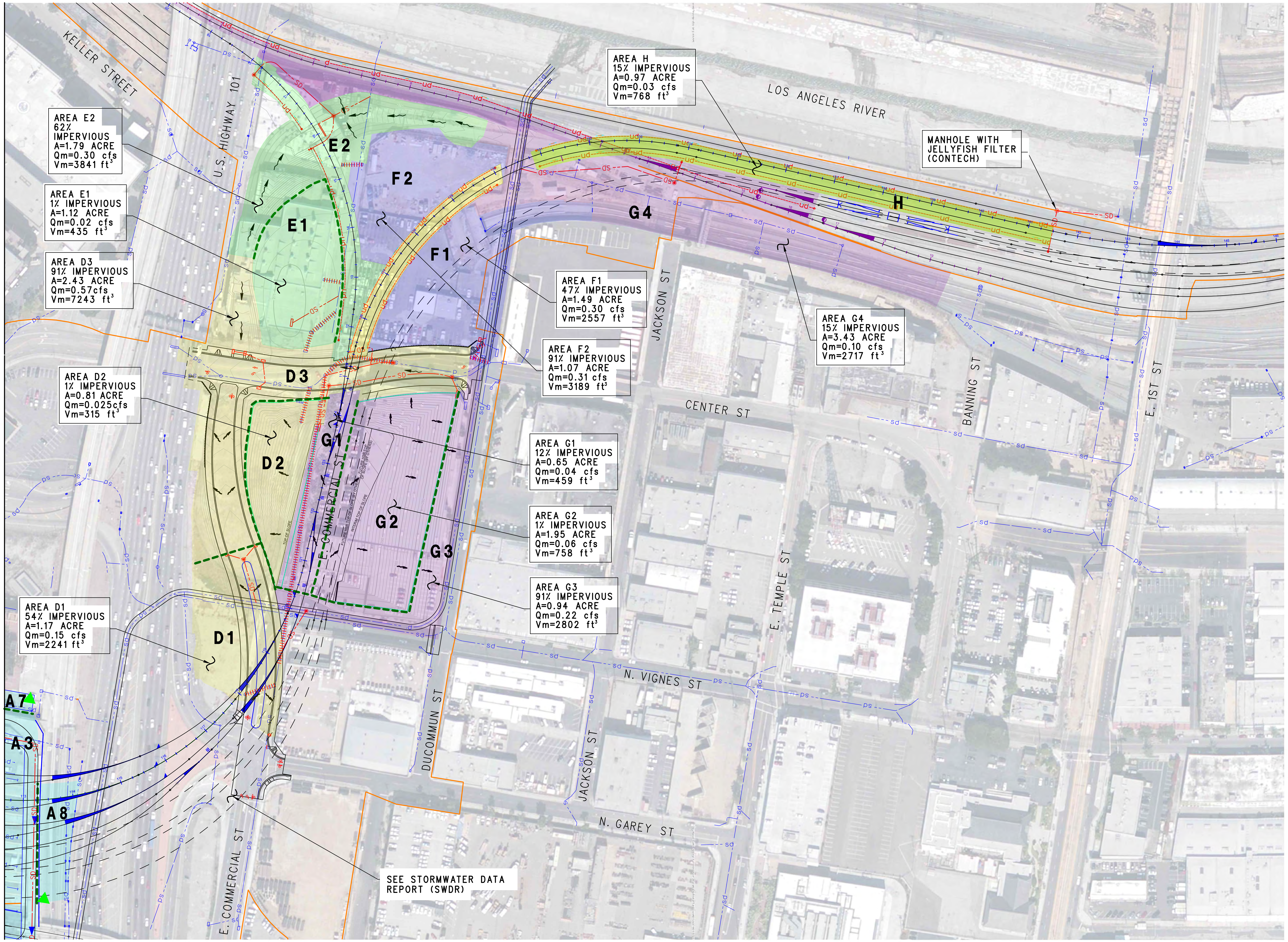
HDR | Metro

LINK UNION STATION

PRELIMINARY LID EXHIBIT
SHEET 4 OF 7

SCALE: 1"=100'

DATE: 04-13-2018



NOTE:

LOCATIONS OF BIORETENTION WITH UNDERDRAIN NOT SHOWN FOR EACH DRAINAGE AREA

LEGEND:

- AREA A (A3, A7, A8)
- AREA D (D1, D2, D3)
- AREA E (E1, E2)
- AREA F (F1, F2)
- AREA G (G1, G2, G3, G4)
- AREA H
- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- DRAINAGE SUB-AREA BOUNDARY
- PROJECT FOOTPRINT
- TRACK UNDERDRAIN

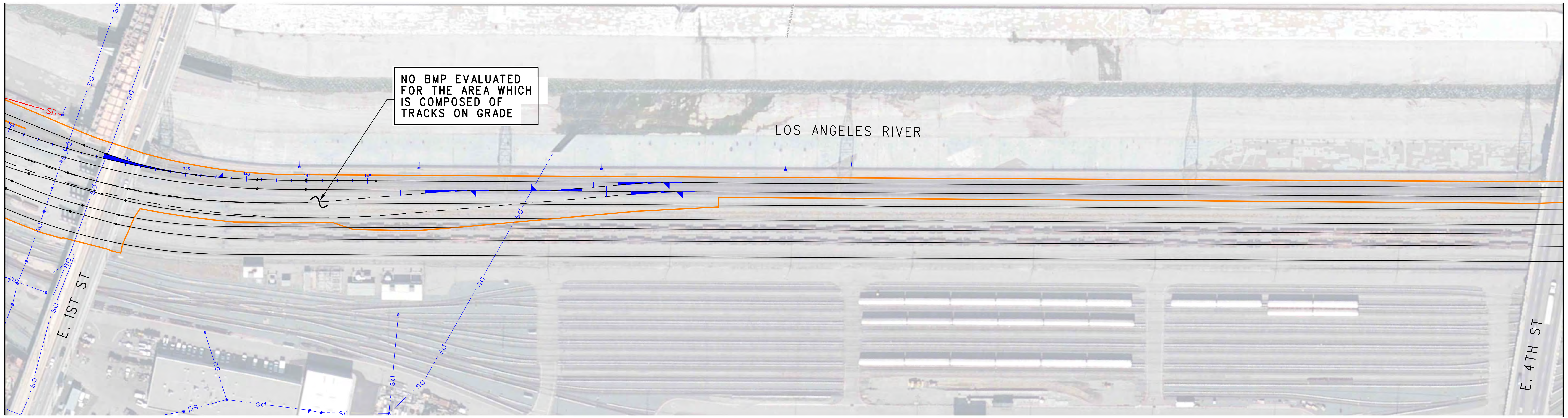
HDR | Metro

LINK UNION STATION

PRELIMINARY LID EXHIBIT
SHEET 5 OF 7

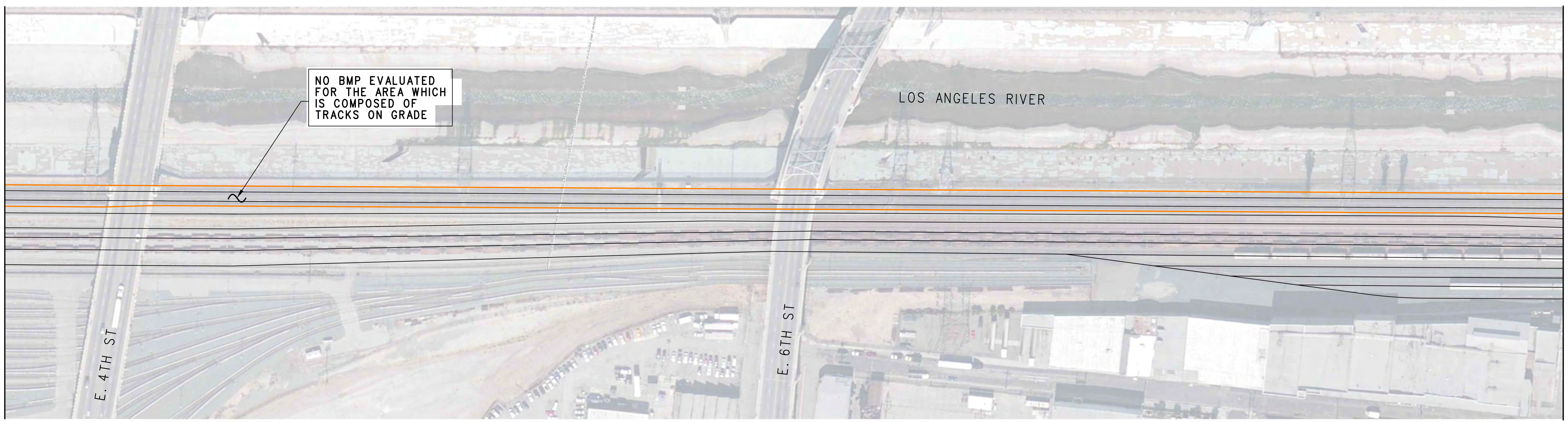
SCALE: 1"=100'
DATE: 04-13-2018

SEE EXHIBIT 5 OF 7
MATCH LINE



MATCH LINE
SEE BELOW LEFT

SEE ABOVE RIGHT
MATCH LINE



MATCH LINE
SEE EXHIBIT 7 OF 7

LEGEND:

--sd--	EXISTING STORM DRAIN
——	PROJECT FOOTPRINT

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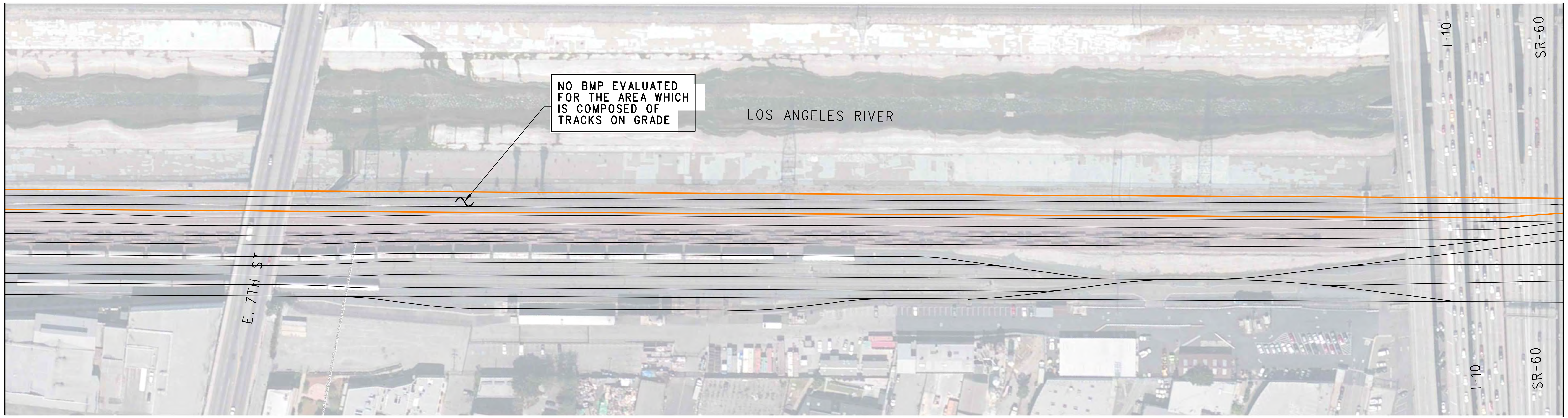
LINK UNION STATION

PRELIMINARY LID EXHIBIT
SHEET 6 OF 7

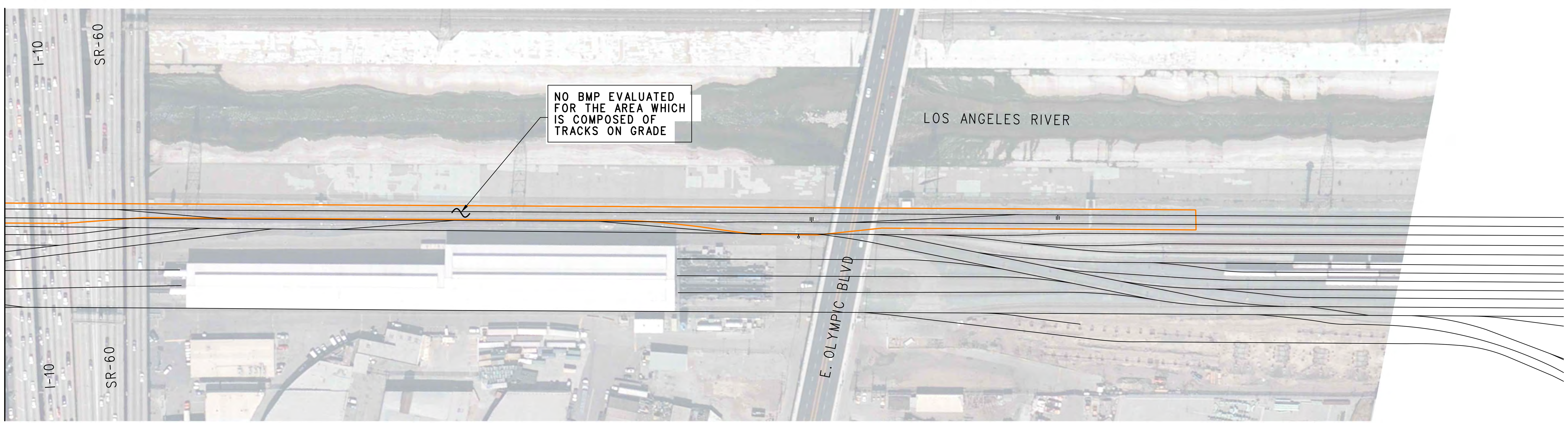
SCALE: 1"=100'
DATE: 04-13-2018

SEE EXHIBIT 6 OF 7
MATCH LINE



MATCH LINE
SEE BELOW LEFT

SEE ABOVE RIGHT
MATCH LINE



LEGEND:

PROJECT FOOTPRINT

HDR | Metro | LINK UNION STATION
PRELIMINARY LID EXHIBIT
SHEET 7 OF 7 | SCALE: 1"=100'
DATE: 04-13-2018

Appendix D:
Stormwater Process Diagram

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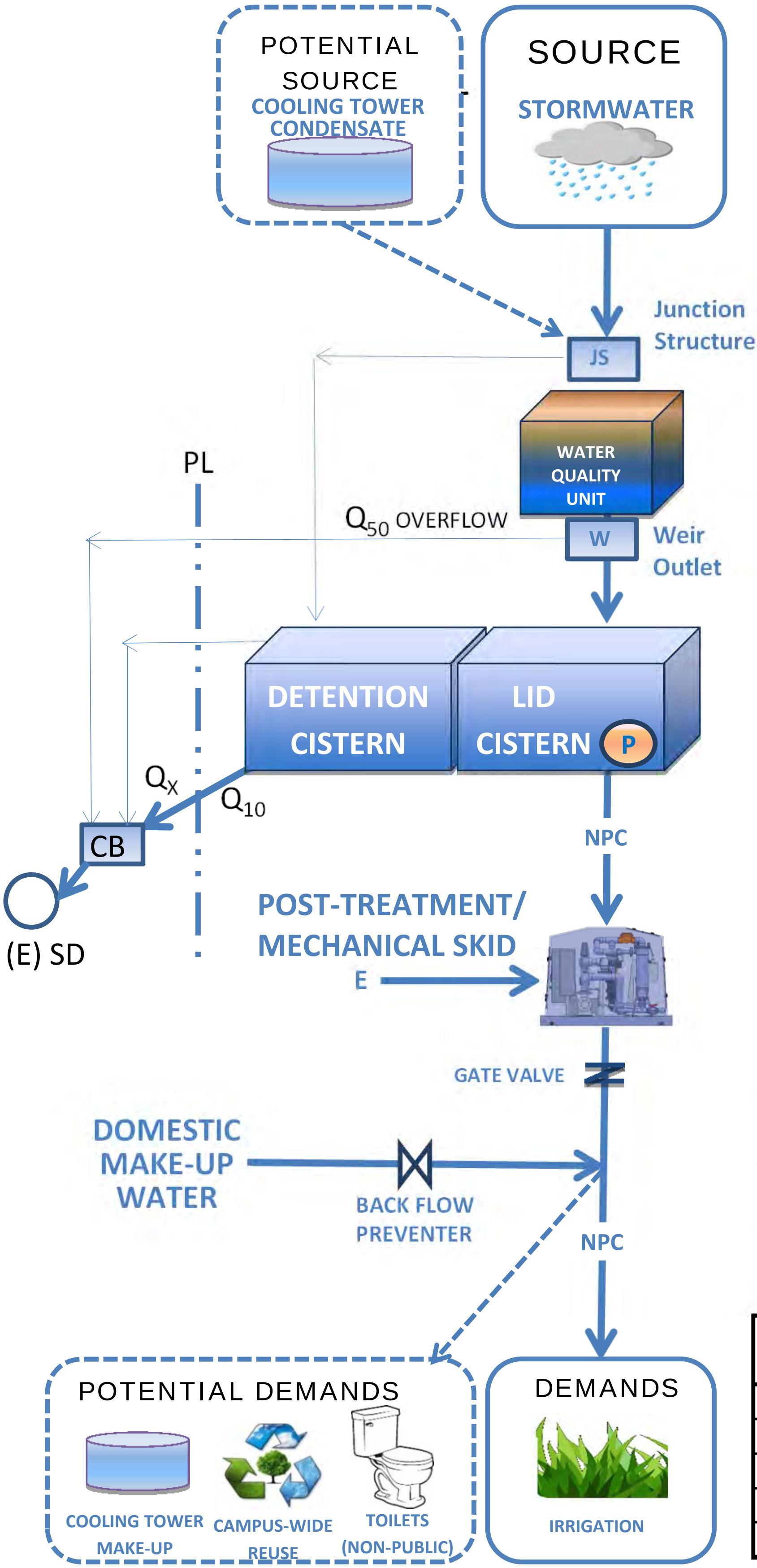
11/12/2018

Link Union Station
Stormwater Process Diagram

w2 design



Source	Volume Per Design Storm	
	cu-ft	gal
Stormwater (Q50)	470,779	3,521,425

Condensate is not considered at this time

Capture & Use

	Volume		Flow
	cu-ft	gal	cfs
LID (85th)	77,178	577,288	5.88

Detention

	Volume		Flow
	cu-ft	gal	cfs
10-Year Pre	242,655	1,815,057	33.98
50-Year Post	470,779	3,521,425	64.77
Delta (50yr - 10yr)	228,124	1,706,368	30.79

Notes:
1. Assumes public line is Q10
2. Qx size to be verified after property line
3. Post-treatment includes UV disinfection and microfiltration
4. NPC = Non-Potable Cistern
5. PL = Property Line
6. CB = Catch Basin
7. Detention cistern sizing will be the difference of the total detention and LID sizing

Demands	Volume / Day	
	cu-ft	gal
Irrigation		
Cooling Tower		
Campus-wide reuse		
Toilets (non-Public)		
Total		

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Appendix E:
Cistern Details

The cistern details are used as a reference for preliminary design purposes only and are subject to change.

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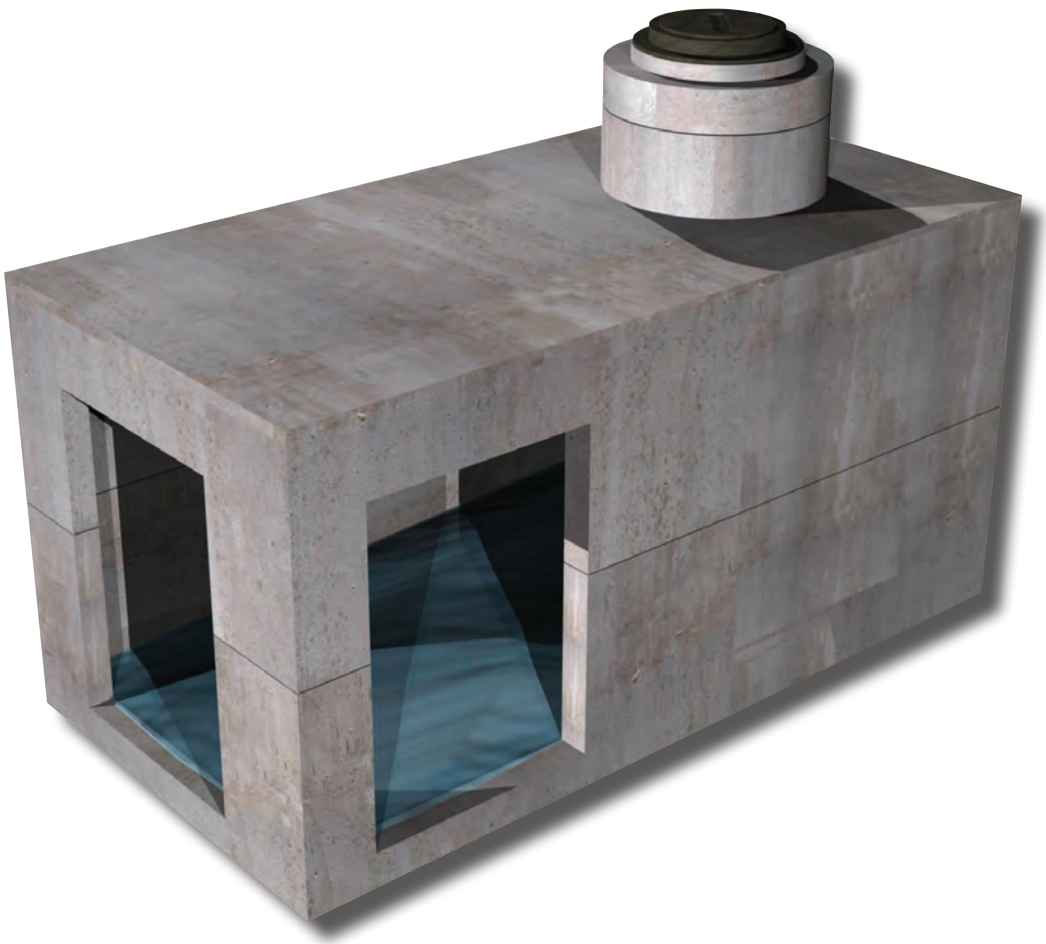
STORMCAPTURE®

StormCapture Modular Stormwater Management System for Infiltration, Detention, Retention and Treatment



Call us today **(800) 579-8819** or visit our website for detailed product information, drawings and design tools at **www.oldcastlestormwater.com**

DETENTION / RETENTION

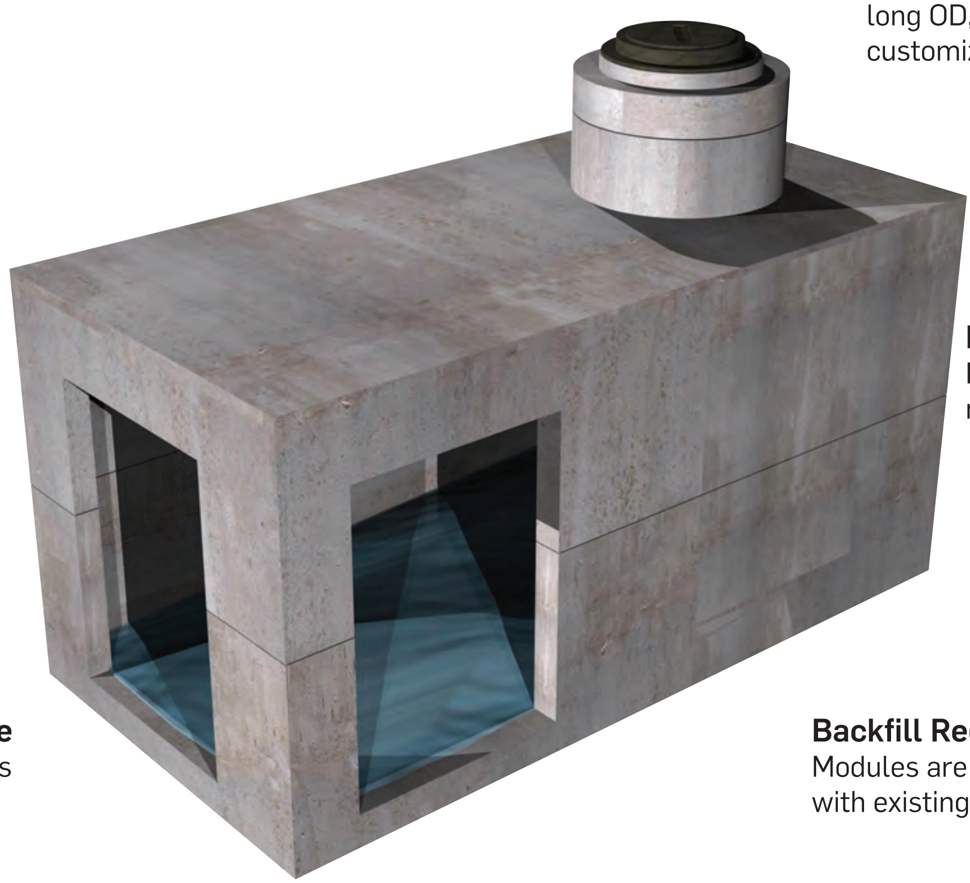
StormCapture® Module

Large Storage Capacity
Smaller system footprint for greater design flexibility.

Traffic Loading
Only requires 6" of cover.

Modular Design
Precast concrete modules measure 8' wide by 16' long OD, (7' x 15' ID), with customizable heights.

Custom Sizes
Available in internal heights from 2' to 14' to best-fit site needs.



Easy to Install
Fast installation with minimal handling.

Design Assistance
Let our professionals customize for your specific needs.

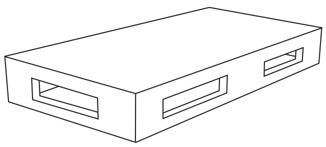
Backfill Requirements
Modules are typically backfilled with existing site materials.

Treatment Train
Available with pre-treatment, post-treatment, or both.

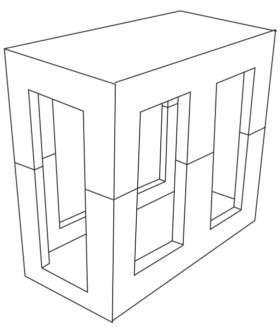
Construction Site Friendly
Contractor does not have to relinquish any ground on the site once the StormCapture system is installed.

INSTALLED IN JUST ONE DAY

Module Sizes



SC1 - Single piece modules can be used for applications from 2' to 7' tall. Appropriate for cisterns, infiltration, detention and retention systems. SC1 modules are typically installed on minimally compacted gravel base, depending on specific project requirements.



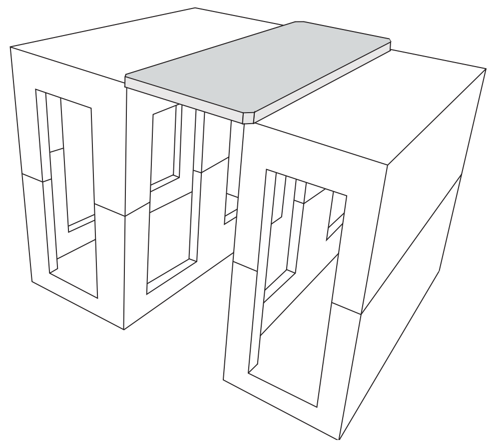
SC2 - Two piece modules can be used for applications from 7' to 14' tall for maximum storage capacity in a condensed footprint. Appropriate for cisterns, infiltration, detention and retention systems. SC2 modules are typically installed on compacted native subgrade.

Module Sizes & Capacities

Modules are 8'x16' outside dimensions. Capacity varies by configuration of openings.

Inside Dimensions (ft)	Capacity Range (ft^3)	Inside Dimensions (ft)	Capacity Range (ft^3)
7x15x2	210-212	7x15x9	945-1,027
7x15x3	315-325	7x15x10	1,050-1,140
7x15x4	420-442	7x15x11	1,155-1,257
7x15x5	525-559	7x15x12	1,260-1,374
7x15x6	630-676	7x15x13*	1,365-1,491
7x15x7	735-793	7x15x14*	1,470-1,608
7x15x8	840-910		

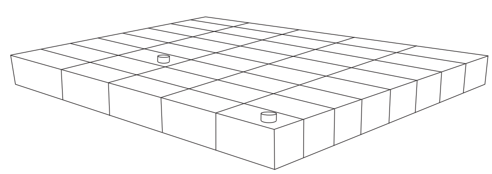
* Special design considerations required and limited availability

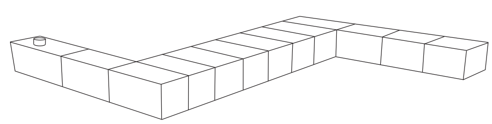


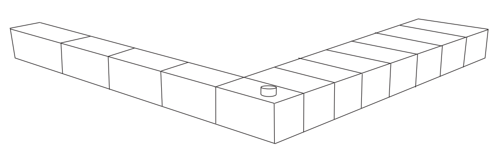
Link Slab - Unique design allows for significant reduction in the quantity of modules and associated costs, while providing maximum storage capacity.

Endless Configurations

Contact us today to start designing your system!







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Appendix F:
Bioretention Sizing

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LINK US BIORETENTION Sizing Area D1

$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$

Parameters	Parameters	Notes	
Mitigated Volume (ft^3)	**V_m**	Per HydroCalc	2,240
Design Volume (ft^3)	**$V_{design} = 1.5\,V_m$**	Biofilterion facilities to be sized to capture and treat 150% of the design capture volume	3,360
Measured Infiltrate Rate (in/hr)	**$K_{sat,\ media}$**	Assumed 5 in/hr	5.0
Factor of Safety	**FS**	FS=2 if soil infiltration test and geotechnical report from professional GE is done, FS= 6 if only a boring was done.	6.0
Design Infiltrate Rate (in/hr)	**$K_{sat,\ design}$**		0.8
Time to fill (hrs)	**T_{fill}**	T_{fill} = 3 hrs, unless a hydrologic routing model is used	3.0
Maximum Ponding Depth (ft)	**$d_{p,max}$**	Maximum = 18 in	1.5
Design Infiltration Area (sf)	**A_{min}**	$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$	1,967

LINK US BIORETENTION Sizing Area D3

$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$

Parameters	Parameters	Notes	
Mitigated Volume (ft^3)	**V_m**	Per HydroCalc	7,243
Design Volume (ft^3)	**$V_{design} = 1.5\,V_m$**	Biofilterion facilities to be sized to capture and treat 150% of the design capture volume	10,865
Measured Infiltrate Rate (in/hr)	**$K_{sat,\ media}$**	Assumed 5 in/hr	5.0
Factor of Safety	**FS**	FS=2 if soil infiltration test and geotechnical report from professional GE is done, FS=6 if only a boring was done.	6.0
Design Infiltrate Rate (in/hr)	**$K_{sat,\ design}$**		0.8
Time to fill (hrs)	**T_{fill}**	T_{fill} = 3 hrs, unless a hydrologic routing model is used	3.0
Maximum Ponding Depth (ft)	**$d_{p,max}$**	Maximum = 18 in	1.5
Design Infiltration Area (sf)	**A_{min}**	$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$	6,360

LINK US BIORETENTION Sizing Area E2

$$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$$

Parameters	Parameters	Notes	
Mitigated Volume (ft^3)	V_m	Per HydroCalc	3,840
Design Volume (ft^3)	V_{design} = 1.5 V_m	Biofilterion facilities to be sized to capture and treat 150% of the design capture volume	5,760
Measured Infiltrate Rate (in/hr)	$K_{sat, media}$	Assumed 5 in/hr	5.0
Factor of Safety	FS	FS=2 if soil infiltration test and geotechnical report from professional GE is done, FS= 6 if only a boring is done	6.0
Design Infiltrate Rate (in/hr)	$K_{sat, design}$		0.8
Time to fill (hrs)	T_{fill}	T_{fill} = 3 hrs, unless a hydrologic routing model is used	3.0
Maximum Ponding Depth (ft)	$d_{p,max}$	Maximum = 18 in	1.5
Design Infiltration Area (sf)	A_{min}	$A_{min}=V_{Design}/[(T_{fill}\times K_{Sat,Design})/12)+d_p]$	3,372

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Appendix G:
Contech StormFilter

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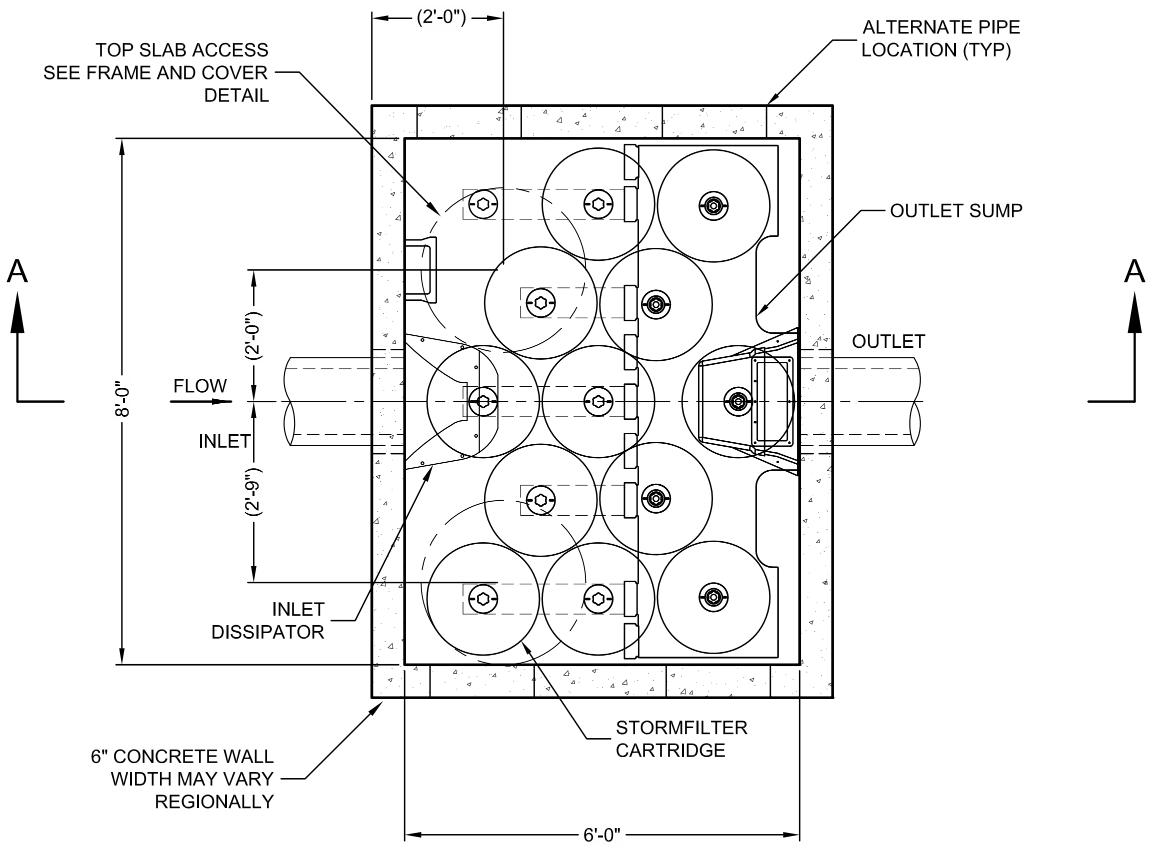
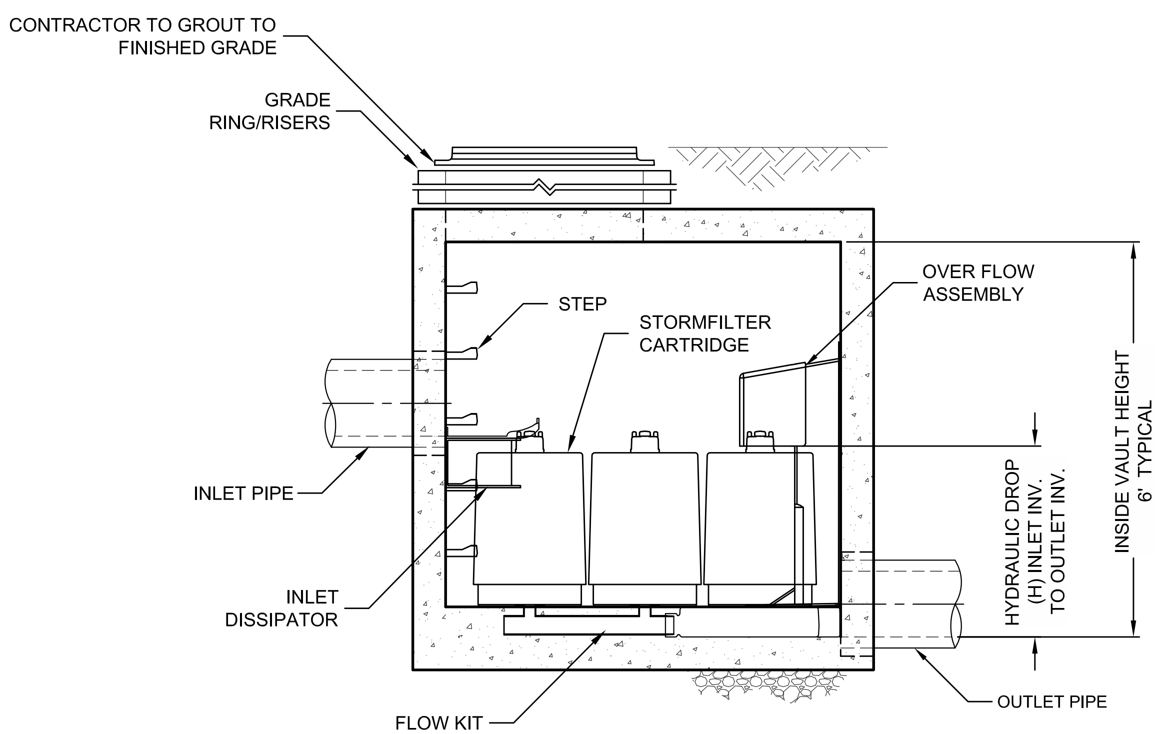


SECTION B-B

VAULT STYLE: OUTLET SUMP (NIB)



SECTION A-A

The Stormwater Management StormFilter®

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,322,629; 5,524,576; 5,707,527; 5,985,157; 6,027,639; 6,649,048; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

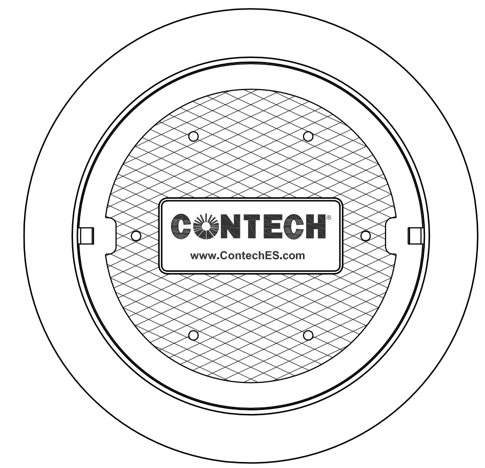
STORMFILTER DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD VAULT STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (12). VAULT STYLE OPTIONS INCLUDE OUTLET BAY (7).

STORMFILTER 8X6 PEAK HYDRAULIC CAPACITY IS 1.8 CFS. IF THE SITE CONDITIONS EXCEED 1.8 CFS AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"		18"		LOW DROP	
RECOMMENDED HYDRAULIC DROP (H)	3.05'		2.3'		1.8'	
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²
CARTRIDGE FLOW RATE (gpm)	22.5	11.25	15	7.5	10	5



FRAME AND COVER

(DIAMETER VARIES)

N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs)	*
PEAK FLOW RATE (cfs)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
# OF CARTRIDGES REQUIRED	*
CARTRIDGE FLOW RATE	*
MEDIA TYPE (CSF, PERLITE, ZPG, GAC, PHS)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE #1	*	*	*
INLET PIPE #2	*	*	*
OUTLET PIPE	*	*	*

UPSTREAM RIM ELEVATION	*
DOWNSTREAM RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 39 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER VAULT (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL VAULT SECTIONS AND ASSEMBLE VAULT.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

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ENGINEERED SOLUTIONS LLC
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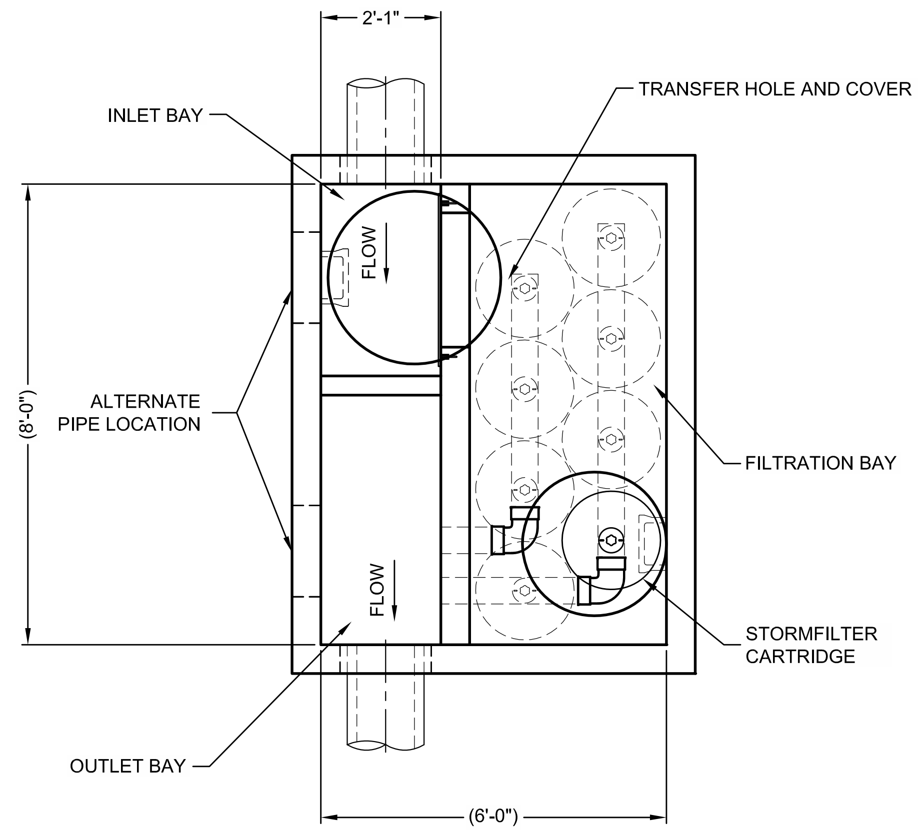
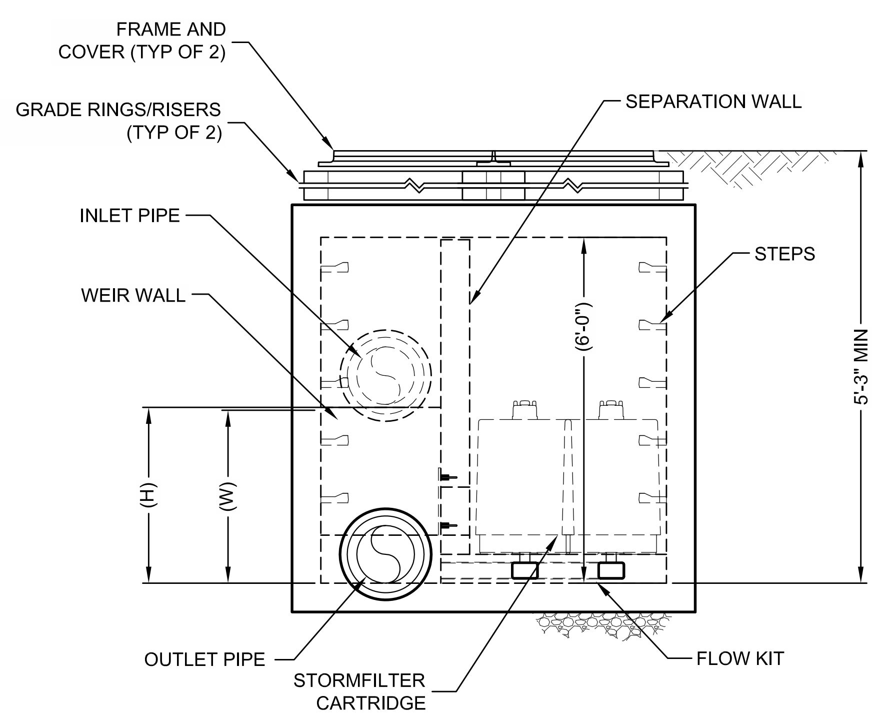
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

SF806
STORMFILTER
STANDARD DETAIL

I:\STORMWATER\COMMOPS\10 STORMFILTER\40 STANDARD DRAWINGS\VAULT\SF0806-DTL.DWG 1/23/2014 10:15 AM



PLAN



ELEVATION

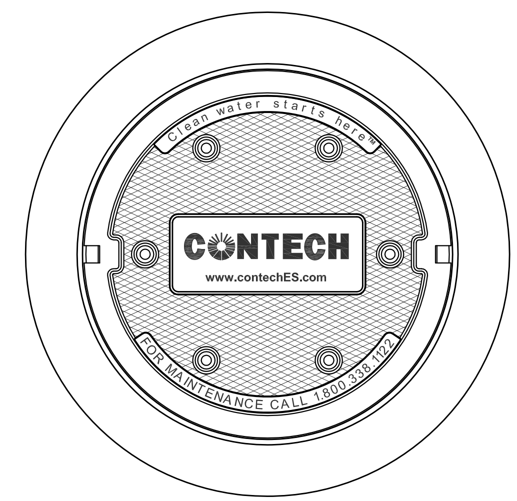
The Stormwater Management StormFilter®

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,322,629; 5,624,576; 5,707,527; 5,985,157; 6,027,639; 6,649,048; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

STORMFILTER DESIGN TABLE

- THE 8' x 6' PEAK DIVERSION STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCALLY APPROVED SURFACE AREA SPECIFIC FLOW RATE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD.
- THE PEAK DIVERSION STORMFILTER IS AVAILABLE IN A LEFT INLET (AS SHOWN) OR RIGHT INLET CONFIGURATION.
- ALL PARTS AND INTERNAL ASSEMBLY PROVIDED BY CONTECH UNLESS OTHERWISE NOTED.

CARTRIDGE HEIGHT	27"		18"		LOW DROP	
SYSTEM HYDRAULIC DROP (H - REQ'D. MIN.)	3.05'		2.3'		1.8'	
HEIGHT OF WEIR (W)	3.00'		2.25'		1.75'	
TREATMENT BY MEDIA SURFACE AREA	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²
CARTRIDGE FLOW RATE (gpm)	22.5	11.25	15	7.5	10	5



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs)	*
PEAK FLOW RATE (cfs)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
# OF CARTRIDGES REQUIRED	*
CARTRIDGE FLOW RATE	*
MEDIA TYPE (CSF, PERLITE, ZPG)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE	*	*	*
OUTLET PIPE	*	*	*

INLET BAY RIM ELEVATION	*
FILTER BAY RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

PERFORMANCE SPECIFICATION

FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. **RADIAL MEDIA DEPTH SHALL BE 7-INCHES**. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST **37 SECONDS**.
SPECIFIC FLOW RATE SHALL BE **2 GPM/SF (MAXIMUM)**. SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF). MEDIA VOLUMETRIC FLOW RATE SHALL BE **6 GPM/CF OF MEDIA (MAXIMUM).**

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
F. CONTRACTOR TO REMOVE THE TRANSFER HOLE COVER WHEN THE SYSTEM IS BROUGHT ONLINE.

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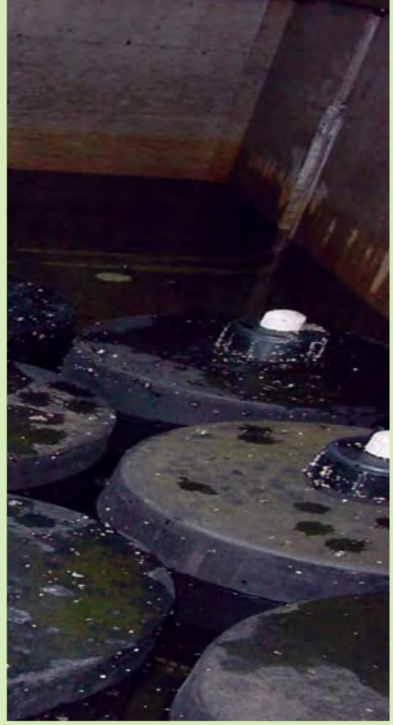
THE STORMWATER MANAGEMENT STORMFILTER
8' x 6' PEAK DIVERSION STORMFILTER
STANDARD DETAIL






CONTECH®
ENGINEERED SOLUTIONS

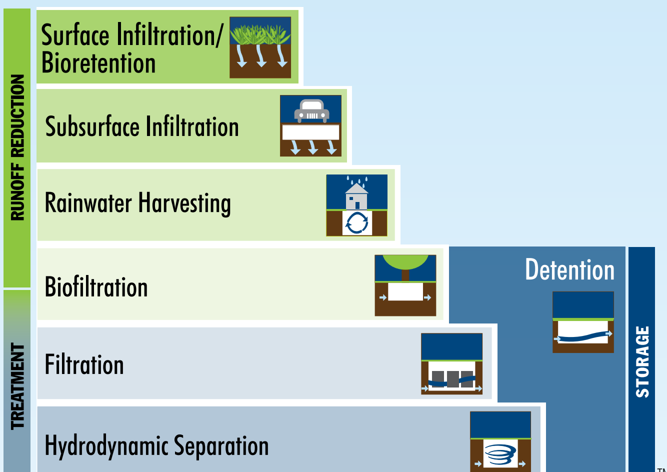
The Stormwater Management StormFilter®

Solutions Guide

Stormwater Filtration

Selecting the right stormwater solution just got easier...

It's simple to choose the right low impact development (LID) solution to achieve your runoff reduction goals with the Contech UrbanGreen® Staircase. First, select the runoff reduction practices that are most appropriate for your site, paying particular attention to pretreatment needs. If the entire design storm cannot be retained, select a treatment best management practice (BMP) for the balance. Finally, select a detention system to address any outstanding downstream erosion.



Highly Effective Pollutant Removal

Stormwater quality standards are becoming increasingly complex, especially with the advent of total maximum daily load (TMDL) requirements. Meeting pollutant reduction goals typically requires a technology that is highly effective at removing solids and associated pollutants from stormwater. In some cases, the technology must also be capable of removing dissolved pollutants such as metals and phosphorus. Using a variety of media, filtration systems can meet that need.

For almost two decades the Stormwater Management StormFilter® has helped you meet the most stringent stormwater requirements. The system has been continually tested and refined to ensure maximum reliability and performance.

Learn more about filtration at www.ContechES.com/stormfilter

> The Stormwater Management StormFilter helps you meet the most stringent stormwater requirements ❖❖❖

Choosing the Right System

The Fundamentals of Filtration

The performance and longevity of media filtration systems is governed by a number of variables that must be carefully considered when evaluating systems, including media type, media gradation, hydraulic loading rate. Understanding these variables requires careful testing and development of performance and longevity data to support proper filter design.

Media Surface Area

Filtration flow rates are typically expressed as a surface area specific operating rate such as gallons per minute per square foot (gpm/ft^2) of surface area. Lower specific operating rates translate to better performance and longer maintenance cycles. Specific operating rates higher than 2 gpm/ft^2 of media surface area negatively impact performance and longevity.

Surface vs. Radial Cartridge Filtration

When assessing filtration systems, it is important to consider whether filtration occurs primarily at the media surface or throughout a bed of media like in radial-cartridge filters. All else equal, radial-cartridge filters are longer lasting, since pollutants are captured and stored throughout the bed, as opposed to predominantly on the media surface. Radial cartridge filters capture more mass of pollutants per unit area of filter surface. Surface filters, such as membranes, are prone to rapid failure due to clogging, as pollutants occlude the media surface which requires frequent backwashing.

Media Hydraulic Conductivity and Flow Control

Filtration media is able to pass more flow per unit of media when it is new versus when it has been in operation for a while. With time, pollutants accumulate in the media bed and reduce its hydraulic capacity. It is critical that filtration devices are designed with excess hydraulic capacity to account for this loss. Also, finer media gradations remove finer particles, but have lower hydraulic capacity and occlude more rapidly. High performance and superior longevity can be achieved by controlling the flow through a more coarse media bed.

Performance: Laboratory Testing

Laboratory testing provides a means to generate hydraulic and basic performance data, but should be complimented with long-term field data. Laboratory performance trials should be executed with a fine sediment gradation such as Sil-Co-Sil 106 which has a median particle size of 22 microns. Testing with coarser gradations is not likely to be representative of field conditions.

Performance: Field Testing

Long-term field evaluations should be conducted on all filtration devices. Field studies should comply with the Technology Acceptance Reciprocity Partnership (TARP), Environmental Technology Verification (ETV) or the Technology Assessment Protocol – Ecology (TAPE) protocols. Testing should be overseen by a reputable third-party to be considered valid.

Longevity

It is essential that loading trials be conducted to evaluate the longevity of a media filter. These trials must be executed with "real" stormwater solids and not silica particles. Reliance on silica particles to assess longevity grossly overstates the loading capacity of the media and the results of such trials should not be relied on. Knowing how much mass a media filter can capture before failure allows it to be sized for a desired maintenance interval by estimating the pollutant load that will be delivered to the filter.

The Stormwater Management StormFilter®

A best management practice (BMP) designed to meet stringent regulatory requirements; the Stormwater Management StormFilter removes the most challenging target pollutants – including fine solids, soluble heavy metals, oil, and total nutrients – using a variety of media. For more than two decades, StormFilter has helped clients meet their regulatory needs and through product enhancements the design continues to be refined for ease of use.

Here's Why StormFilter is the Best Filter Available:

Superior Hydraulics

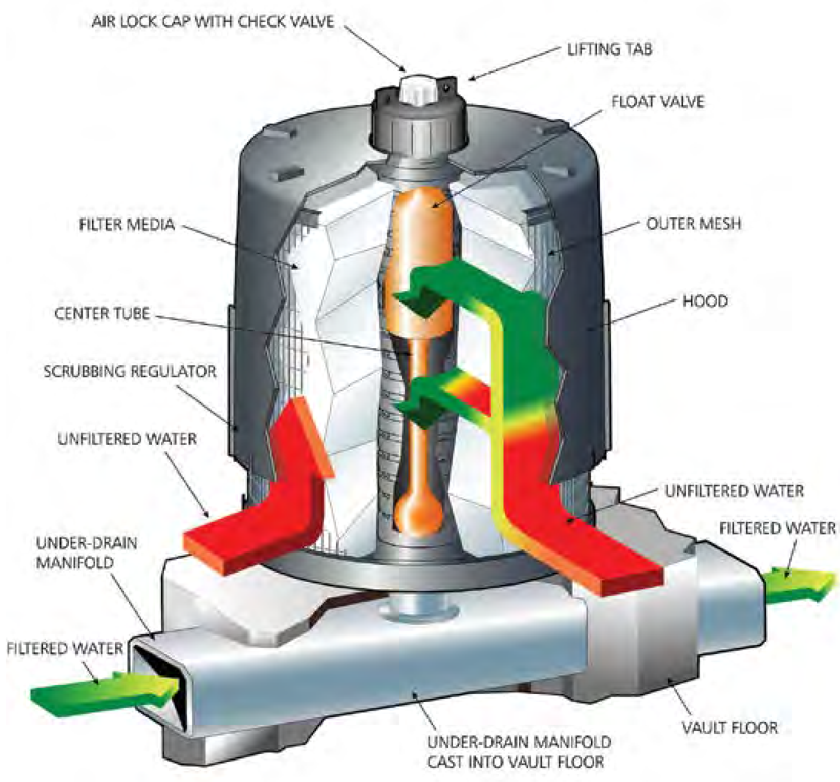
- External bypass – Protects treatment chamber from high flows and ensures captured pollutants are not lost during low frequency, high intensity storm events
- Multiple cartridge heights – Minimize head loss to fit within the hydraulic grade line and shrink system size, reducing install costs
- Over 30 StormFilter configurations in use across the country

Reliable Longevity

- Unique surface-cleaning mechanism – Prevents surface blinding, ensures use of all media, and prolongs cartridge life
- One to two-year maintenance cycles - Fewer maintenance events compared to similar products reduces costs over the lifetime of the system
- 15-years of maintenance experience – Predictable long-term performance comes standard

Proven Performance

- Only proven filter on the market - Performance verified by the WA Ecology and NJ DEP, and system approved for use with numerous local agencies
  - Qualifies for LEED® Sustainable Site Credit 6.2 – Stormwater Quality Control
- Achieve water quality goals with confidence – Easy approval speeds permitting
- 8th Generation Product – Design refined and perfected over two decades of research and experience
- Full-scale testing at more than 10 sites around the United States



Underground System Maximizes Land Use and Development Profitability

- Save land space, allow denser development and reduce sprawl
- Add parking, increase building size, develop outparcels by eliminating aboveground systems
- Compact design reduces construction and installation costs by limiting excavation

Patented Siphon-Actuated Filtration

During a storm, runoff passes through the filtration media and starts filling the cartridge center tube. Air below the hood is purged through a one-way check valve as the water rises. When water reaches the top of the float, buoyant forces pull the float free and allow filtered water to drain.

After the storm, the water level in the structure starts falling. A hanging water column remains under the cartridge hood until the water level reaches the scrubbing regulators at the bottom of the hood. Air then rushes through the regulators releasing water and creating air bubbles that agitate the surface of the filter media, causing accumulated sediment to drop to the vault floor. This patented surface-cleaning mechanism helps restore the filter's permeability between storm events.

See the StormFilter in action at www.ContechES.com/stormfilter

Unique surface-cleaning mechanism prevents surface blinding, ensures use of all media, and prolongs cartridge life

For even more information, check out the StormFilter Animation available at www.conteches.com/videos

Configurations and Applications

The StormFilter technology can be configured to meet your unique site requirements. Here are a few of the most common configurations, however many other configurations are available. Please contact your Contech Project Consultant to evaluate the best options for your site or find out more in the **StormFilter Configuration Guide available on www.ContechES.com/stormfilter.**

Upstream Treatment Configurations

The following suite of StormFilter configurations are easily incorporated on sites where LID site design is recommended. These low-cost, low-drop, point-of-entry systems also work well when you have a compact drainage area.

CatchBasin StormFilter

- Combines a catch basin, a high flow bypass device, and a StormFilter cartridge in one shallow structure
- Treats sheet flow
- Uses drop from the inlet grate to the conveyance pipe to drive the passive filtration cartridge
- No confined space required for maintenance

Curb Inlet

- Accommodates curb inlet openings from 3 to 10 feet long
- Uses drop from the curb inlet to the conveyance pipe to drive the passive filtration cartridges

Linear Grate

- Can be designed to meet volume based sizing requirements
- Can be installed in place of and similar to a typical catch basin
- No confined space entry required for maintenance
- Accommodates up to 29 StormFilter cartridges

Infiltration/Retrofit Configuration

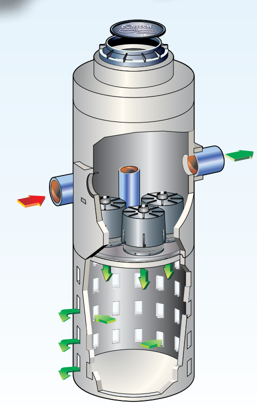
Infiltration

- Provides treatment and infiltration in one structure
- Available for new construction and retrofit applications
- Easy installation

CatchBasin StormFilter

Curb Inlet

Linear Grate



Infiltration

Roof Runoff Treatment Configuration

DownSpout

- Easily integrated into existing gutter systems to treat pollution from rooftop runoff
- Fits most downspout configurations and sizes; single or dual-cartridge models available
- Treats up to 14,000 square feet of rooftop area per dual-cartridge system

Downstream Treatment Configurations

Conventional stormwater treatment involves collecting, conveying and treating stormwater runoff with an end of pipe treatment system before discharging off-site. StormFilter configurations suitable for these applications are listed below and can be engineered to treat a wide range of flows.

Vault / Manhole

- Treats small to medium sized sites
- Simple installation - arrives on-site fully assembled
- May require off-line bypass structure

High Flow

- Treats flows from large sites
- Consists of large, precast components designed for easy assembly on-site
- Several configurations available, including: CON/SPAN®, Panel Vault, Box Culvert, or Cast-In-Place

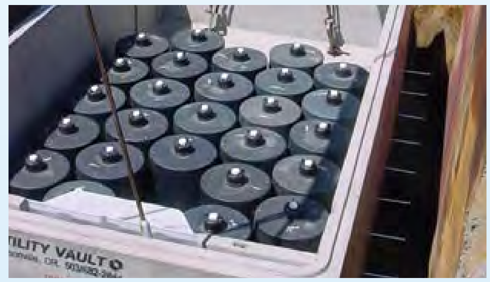
Volume

- Meets volume-based stormwater treatment regulations
- Captures and treats specific water quality volume (WQv)
- Provides treatment and controls the discharge rate
- Can be designed to capture all, or a portion, of the WQv

Peak Diversion

- Provides off-line bypass and treatment in one structure
- Eliminates material and installation cost of additional structures to bypass peak flows
- Reduces the overall footprint of the treatment system, avoiding utility and right-of-way conflicts
- Internal weir allows high peak flows with low hydraulic head losses
- Accommodates large inlet and outlet pipes (up to 36”) for high flow applications

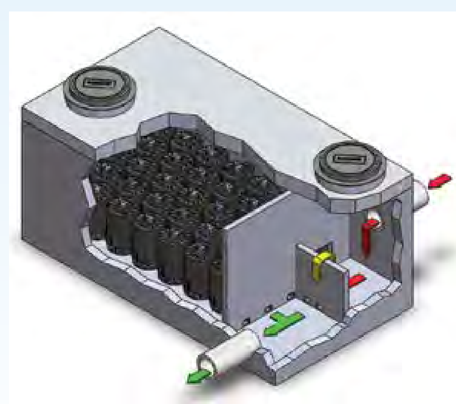
DownSpout StormFilter



Vault

High Flow

Manhole



Peak Diversion

Media Options

Our filtration products can be customized using different filter media to target site-specific pollutants. A combination of media is often recommended to maximize pollutant removal effectiveness.

PhosphoSorb® is a lightweight media built from a Perlite-base that removes total phosphorus (TP) by adsorbing dissolved-P and filtering particulate-P simultaneously.

Perlite is naturally occurring puffed volcanic ash. Effective for removing TSS, oil and grease.

CSF® Leaf Media and MetalRx™ are created from deciduous leaves processed into granular, organic media. CSF is most effective for removing soluble metals, TSS, oil and grease, and buffering acid rain. MetalRx, a finer gradation, is used for higher levels of metal removal.

Zeolite is a naturally occurring mineral used to remove soluble metals, ammonium and some organics.

GAC (Granular Activated Carbon) has a micro-porous structure with an extensive surface area to provide high levels of adsorption. It is primarily used to remove oil and grease and organics such as PAHs and phthalates.

	PhosphoSorb	Perlite	CSF	MetalRx	Zeolite	GAC
Sediments	•	•	•			
Oil and Grease	•	•	•	•		
Soluble Metals	•		•	•	•	
Organics			•	•		•
Nutrients	•	•	•	•	•	
Total Phosphorus	•					

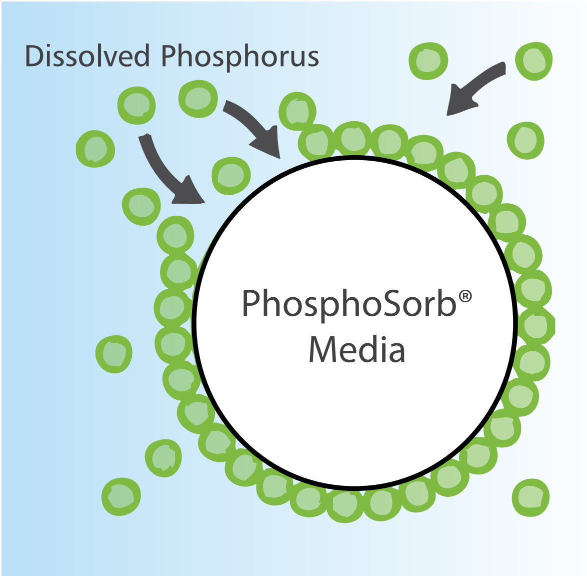
Note: Indicated media are most effective for associated pollutant type. Other media may treat pollutants, but to a lesser degree.

ZPG™ media, a proprietary blend of zeolite, perlite, and GAC, is also available and provides an alternative where leaf media cannot be used.

Focus on Phosphorous

Stormwater runoff with elevated phosphorus concentration can significantly impair water quality. More stringent stormwater regulations calling for higher levels of phosphorus removal are currently being implemented. To meet these requirements, more than just the physical separation of particulate P is needed. That's where the PhosphoSorb media can help.

A cost-effective, lightweight, adsorptive filtration media, PhosphoSorb offers the effective adsorption capacity of dissolved phosphorus and retention capacity of particulate phosphorus. Initial field results suggest removal of greater than 65% of the total phosphorus load can be expected when influent concentrations exceed 0.1 mg/l, and the media can remain in operation for more than 1 year without requiring maintenance due to media occlusion.

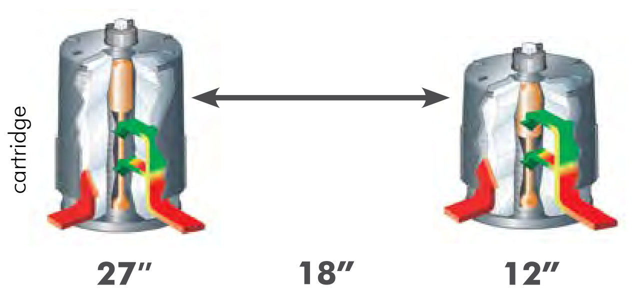


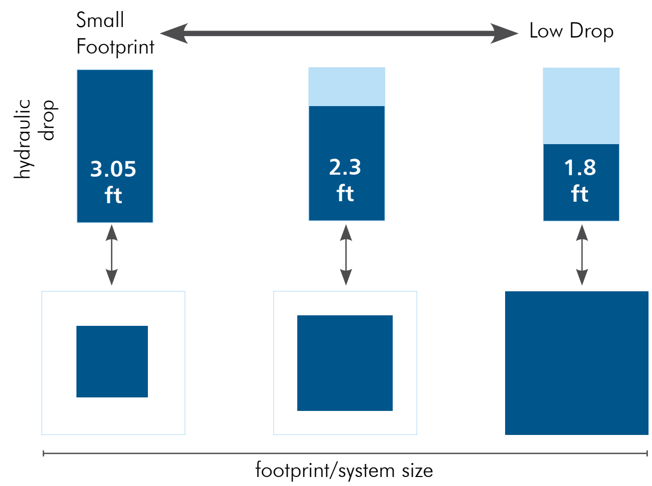
Cartridge Options

With multiple cartridge heights available, you have a choice when fitting a StormFilter system onto your site.

The 27″ cartridge provides 50% more treatment per square foot of system than the 18″ cartridge. So, you are meeting the same treatment standards with fewer cartridges, which means a smaller system.

If you are limited by hydraulic constraints, choose our low drop cartridge, which provide filtration treatment with only 1.8 feet of headloss.





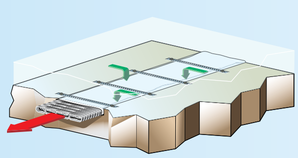
Cartridge Flow Rates

Cartridge Type	Hydraulic Drop	Treatment Capacity (gpm)	
		1 gpm/ft2	2 gpm/ft2
StormFilter 27″	3.05 feet	11.25	22.5
StormFilter 18″	2.3 feet.	7.5	15
StormFilter Low Drop	1.8 feet	5	10
MFS 22″	2.3 feet	9	18
MFS 12″	1.4 feet	5	10

Multiple cartridge heights are available to meet your hydraulics needs

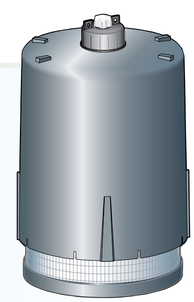
StormFilter Accessories

Drain-Down



- Provides complete dewatering of the StormFilter vault by gradually removing residual water in the sump after the storm event
- Aids in vector control by eliminating mosquito-breeding habitat
- Eliminates putrefaction and leaching of collected pollutants
- Lowers maintenance cost by reducing decanting and disposal volume

Sorbent Hood Cover



- Absorbs free surface oil and grease on contact
- Will not release captured oil, even when saturated
- Made from recycled synthetic fiber

Cartridge Lifting Hook

- Specially designed to help you easily lift cartridges during maintenance

Maintenance

Longevity is a function of applying existing filtration physics to the maximum extent possible in order to decrease maintenance frequency without sacrificing performance. Maintenance is an integral part of ensuring long term effectiveness of a filter system. The quality of treatment can only be guaranteed by a well maintained structure, whether it is proprietary or nonproprietary. The notion that some BMPs, including low impact development (LID) structures, have no maintenance cost burden is a misconception.

Longer Maintenance Intervals Reduce Life Cycle Costs

Maintenance intervals can be a large unseen cost for developers and owners. Including a maintenance interval in the product specification will ensure that no one is surprised with high long term costs.

The Stormwater Management StormFilter can be designed with up to a 2 year maintenance interval, proven by over a decade of installations, which can greatly reduce costs. Our filter cartridges are made with 60% of recyclable material.

Ease of Maintenance Matters

The StormFilter has been optimized over time to make maintenance easy. Cartridges feature a 1/4 turn connector, so they can be quickly removed and installed. A removable hood allows for effortless access to spent media, especially compared to sealed systems that require cutting the cartridge hood. Finally, all StormFilter structures can be accessed without restriction for inspection, media replacement, and washing of structure.

Experience Counts

Contech has over 120,000 StormFilter cartridges in use throughout the country. We have a plant dedicated to the production of filtration cartridges based in Portland, OR, that supports maintenance events with exchange of full cartridge and maintenance contracts. All cartridge components go through a QA/QC review at the refilling point to ensure that the correct media gradation is supplied and that it is packed properly which provides reliable operation and performance.

Not All Stormwater Filtration Systems are the Same

When you choose the Stormwater Management StormFilter, you are choosing the industry leading technology. Our experienced design engineers can help you design the system that will work for your site and your budget.

Maintenance Required If:

Greater than 4″ of sediment is on the structure floor

Greater than ¼″ of sediment is on the top of the cartridges

Greater than 4″ of standing water in vault for more than 24 hours after a storm

Annual StormFilter vault inspection is recommended and it doesn't require confined space enty ❖❖❖

Pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Spent filter media can be dumped directly onto the structure floor, so the emptied lightweight cartridges can be easily removed, thus eliminating the need for handling heavy units.

Easy to access treatment system can make a difference in maintenance expenses.

StormFilter structures can be accessed without confined space for inspection.

The quality of treatment can only be guaranteed by a well maintained structure

LEARN MORE

- Access project profiles, photos, videos and more online at **www.ContechES.com/stormfilter**

CONNECT WITH US

- Call us at 800-338-1122
- Contact your local rep at **www.ContechES.com/localresources**

START A PROJECT

- Submit your system requirements on our product Design Worksheet **www.ContechES.com/start-a-project**

USE OUR ONLINE TOOLS

- Low Impact Development Site Planner **www.ContechES.com/LIDsiteplanner**

CONTECH ENGINEERED SOLUTIONS

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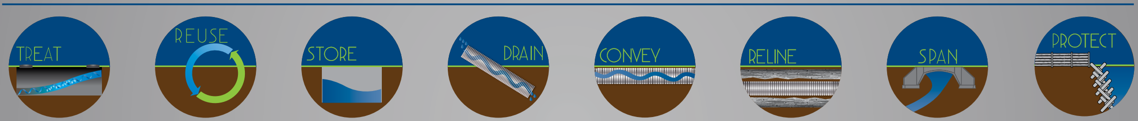

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CONTECH ENGINEERED SOLUTIONS

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StormFilter Configuration Guide

The Stormwater Management StormFilter®

The Stormwater Management StormFilter®

The Stormwater Management StormFilter (StormFilter) is a passive, flow-through, stormwater filtration system. The system is comprised of one or more structures that house rechargeable, media-filled cartridges which trap particulates and adsorb materials such as dissolved metals, hydrocarbons, and nutrients in polluted runoff.

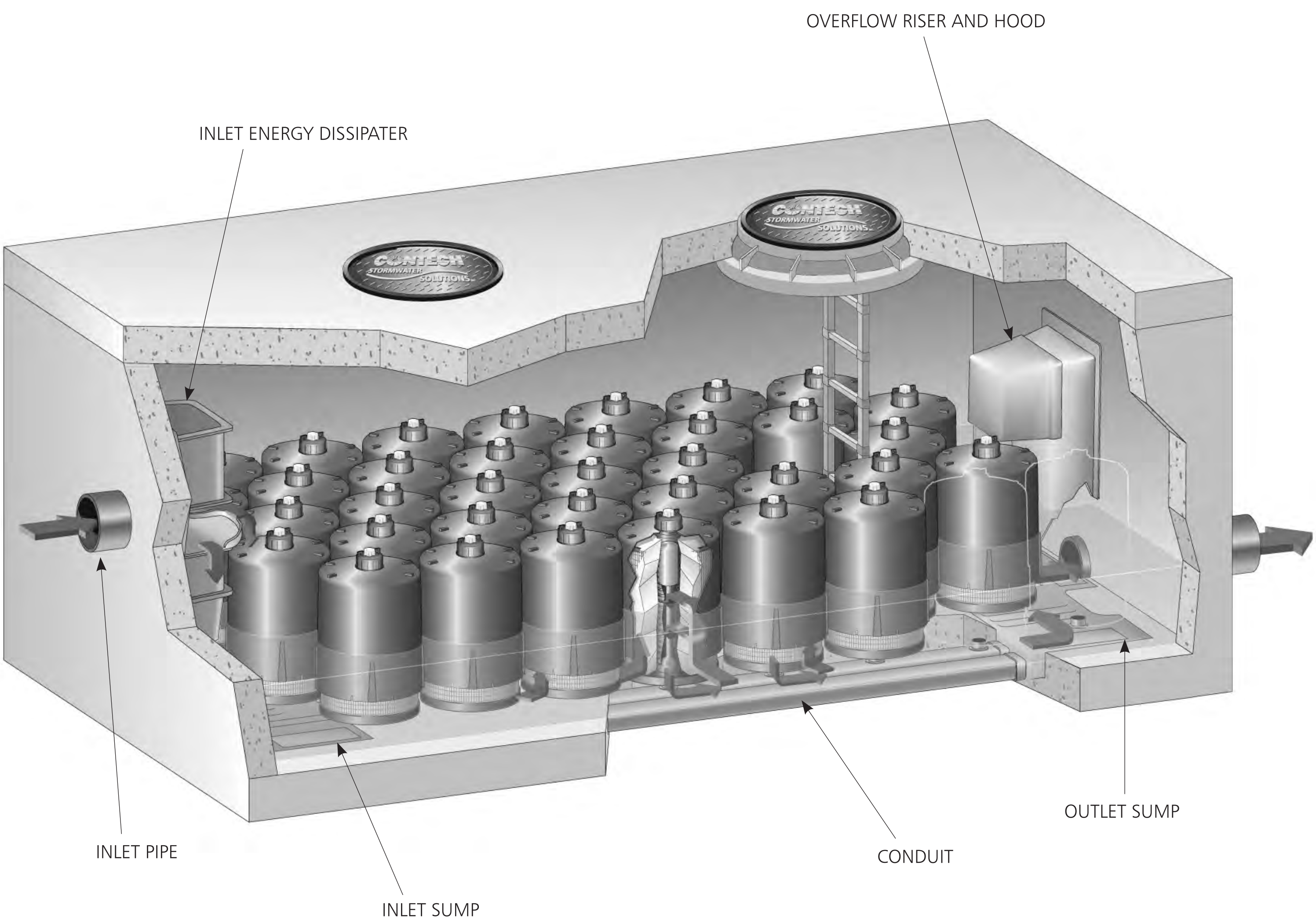
The StormFilter system comes in a variety of configurations and sizes to meet any site need. A variety of filter media is available and can be customized for each site to remove the desired pollutants.

Basic Design

The StormFilter is sized to treat the peak flow of a water quality design storm. The peak flow or WQv is determined from calculations based on the contributing watershed hydrology and from a design storm magnitude set by the local stormwater management agency. The StormFilter system is modular and each unit is designed with the number of cartridges required to meet the peak design flow rate, WQv or cap.

The flow rate through each filter cartridge is set to meet the jurisdictional performance requirements, allowing control over the amount of contact time between the influent and the filter media. The maximum flow rate through each cartridge can be adjusted, between 0.26 gpm/ft^2 and 2 gpm/ft^2 of surface area, using a calibrated restrictor disc at the base of each filter cartridge. Adjustments to the cartridge flow rate will affect the number of cartridges required to treat the peak flow or WQv.

Please contact your local Contech representative for site-specific design assistance.



Basic Operation

Priming System Function

The system is designed to siphon stormwater runoff through the StormFilter cartridge. Stormwater enters a StormFilter cartridge, percolates horizontally through the cartridge's filter media and collects in the center tube where the float valve is in a closed (downward) position.

As water passes through the filter media and into the cartridge's center tube, the air in the cartridge is displaced by the water and purged from beneath the filter hood through the one-way check valve located in the cap. Once the center tube is filled with water, there is enough buoyant force to open the float valve and allow the treated water in the center tube to flow into the under-drain manifold. This causes the check valve to close, initiating a siphon that draws polluted water throughout the full surface area and volume of the filter. Thus, the entire filter cartridge is used to filter water throughout the duration of the storm, regardless of the water surface elevation in the unit. This siphon continues until the water surface elevation drops to the elevation of the hood's scrubbing regulators, and the float returns to a closed position. Utilizing the hydraulic potential in the cartridge, the scrubbing regulators cause the filter surface to be clean of attached sediments thus extending the filter's operational life.

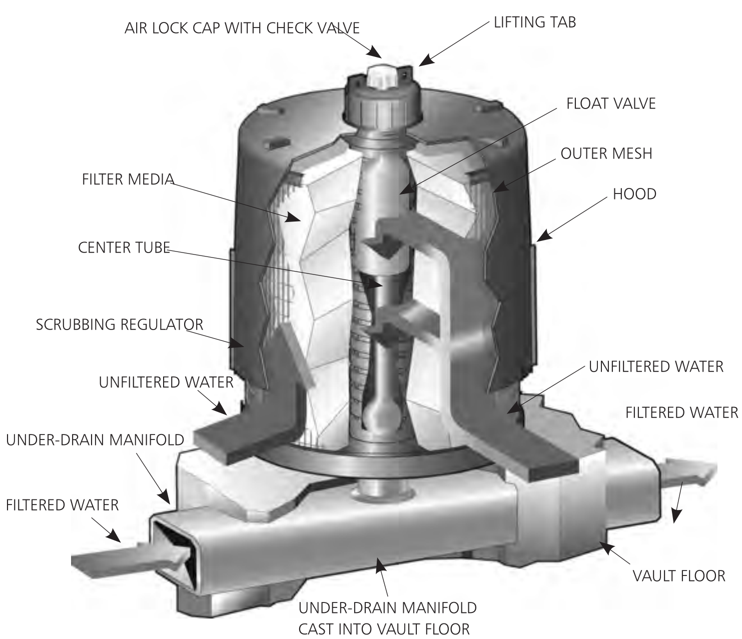
Flow and Valve Control

The filtration rate through a typical StormFilter cartridge can be adjusted so that it has a maximum flow rate of 2 gpm/ft^2 at the design driving head. The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the under-drain manifold. Consisting of a simple orifice disc of a specific diameter, the flow rate through the cartridges can be adjusted to a level that coincides with your treatment requirements by using a disc with the appropriate orifice diameter.

A reduction in flow rate affects the performance of the StormFilter system with regards to both sediment and soluble pollutants. For solids, Stokes' Law predicts the movement of sediment in a fluid and it has been proven that a reduction in the flow velocity through the system will facilitate increased settling and capture of sediments. In addition, some media types have the ability to remove soluble pollutants through chemical processes, like ion exchange. A reduction in the flow velocity through the StormFilter cartridge will increase the contact time between the stormwater and the media, thereby increasing the removal efficiency by increasing the time for a chemical process to take place.

Media type can be changed, but flow rate adjustment requires engineering consultation to ensure hydraulic demands are satisfied.

Through routine maintenance, a media filtration system can adjust the media type to target or update the system to treating specific pollutants, new TMDLs, or changing pollutants of concern. The media change out can provide a long-term solution to changing regulatory requirements.



StormFilter Configurations

The StormFilter technology can be configured to meet your unique site requirements.

Downstream Treatment Configurations

Conventional stormwater treatment involves collecting, conveying and treating stormwater runoff with an end of pipe treatment system before discharging off-site. StormFilter configurations suitable for these applications are listed below and can be engineered to treat a wide range of flows.

Vault/Manhole

The Vault/Manhole consists of one or more precast concrete structures ranging from 48” manholes to 8’ x 24’ vaults. The largest unit treats water quality design flows up to 3.75 cfs, and can be placed in series or in parallel to treat higher flows if needed.

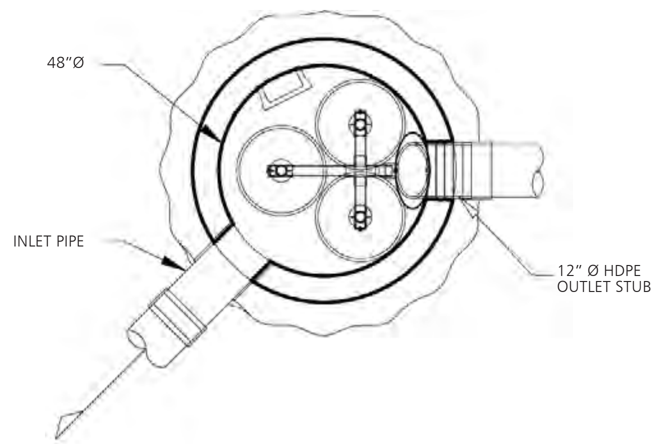
A Vault/Manhole configuration can be installed online or offline from storm system, where the unit has internal overflow bypass. These systems can also be installed offline, where high flows are bypassed around the treatment system and there is no internal overflow. However, if detention, pretreatment, or bypassing is required, it can be installed offline of the storm system.

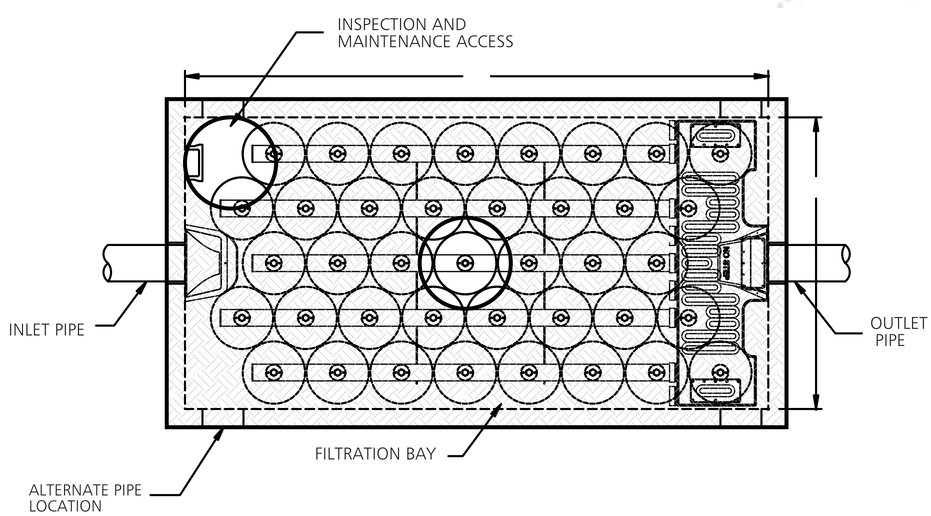
Basic Operation

Vault/Manhole systems are housed in either a vault or manhole. Stormwater first enters the structure through the inlet pipe where it is directed through the energy dissipator. This gently spreads the flow to minimize re-suspension of previously captured pollutants.

Once in the filtration area, the stormwater begins to pond and percolate horizontally through the media contained in the filter cartridges. After passing through the media, treated water that has collected in the cartridge center tube is directed into the outlet sump by an under-drain manifold. The treated water in the outlet sump is then discharged through the outlet pipe.

Precast StormFilter systems have an internal bypass capability from 1.0 cfs to 2.0 cfs, depending upon the size of the system. If peaks flows to the system exceed 2.0 cfs, an offline high flow bypass is needed.





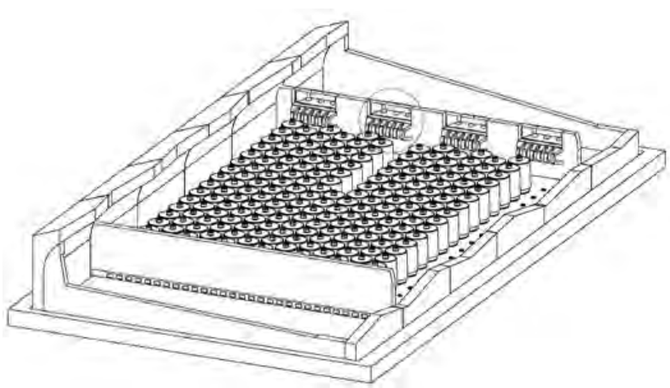
Vault/Manhole StormFilter

High Flow StormFilter

High Flow StormFilter systems can be designed within a variety of structures to meet local requirements and streamline installation. These systems are designed for large sites and large flows. Too big for standard precast structures, they are usually built from precast components that are assembled on site. The High Flow StormFilter is available in several configurations: CON/SPAN®, Panel Vaults, Box Culverts, or Cast-In-Place.

Basic Operation

The High Flow StormFilter design has the same basic configuration and components as the Precast StormFilter but operates on a larger scale.



High Flow StormFilter

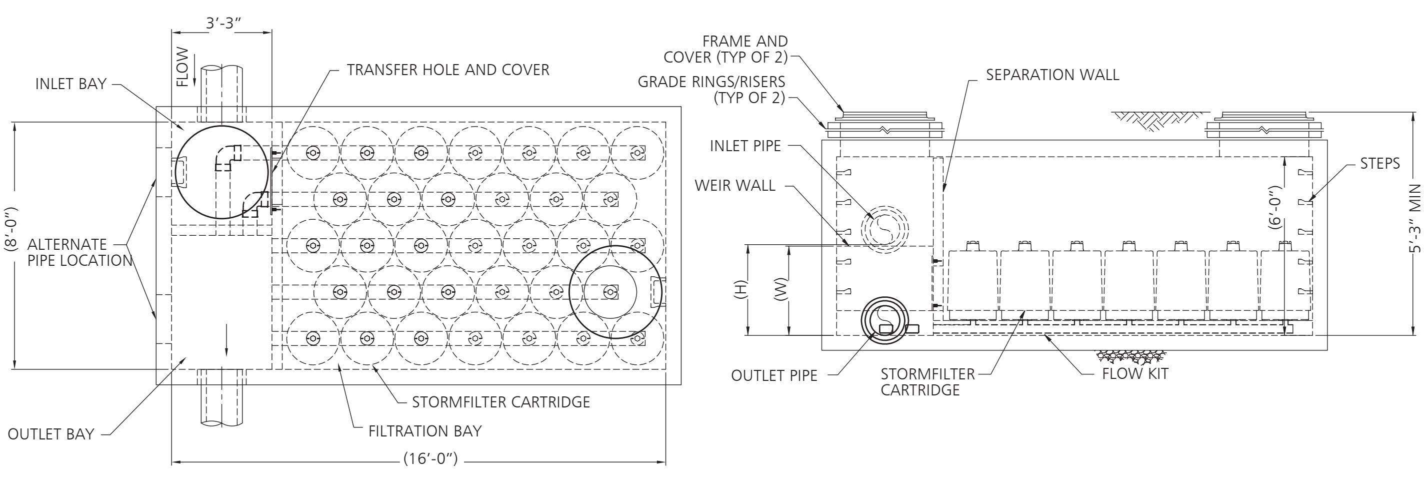
Peak Diversion StormFilter

The Peak Diversion StormFilter includes a treatment chamber and offline by-pass capability in one precast vault. Sizes range from 8’x11” to 8’x24” in most areas. Larger units can treat up to 2.5 cfs depending on cartridge height and the approved flow rate of regulatory jurisdiction. The integrated off-line bypass eliminates upstream flow splitters, downstream junction structures, and additional piping to save space and reduce the overall foot print. This lowers materials and installation cost while reducing potential conflicts with right of way (ROW) boundaries and utilities.

Basic Operation

Stormwater enters the structure through one or two inlet pipes into the inlet bay and low flows are directed to the filtration bay through a transfer opening. Once in the filtration area, the stormwater begins to pond and percolate horizontally through the media contained in the filter cartridges. After passing through the media, treated water that has collected in the cartridge center tube is directed into the outlet bay by an under-drain manifold. The treated water in the outlet sump is then discharged through the outlet pipe.

During large storm events greater than the treatment capacity, peak flows are diverted across the overflow weir directly to the outlet. Even during high flows the cartridges are still operating and water is entering the filtration bay from the inlet bay. This continuous flow into the filter bay helps ensure pollutants can not be washed out during high flow events.



Peak Diversion StormFilter

Volume StormFilter

The Volume StormFilter is designed to meet volume-based regulations where a specific water quality volume (WQv) must be captured and treated. In addition to the treatment, the structure can be sized to capture all or a portion of the WQv.

Restrictor discs inside each cartridge can be used to control the discharge rate from the system. The size of the disc is calibrated to provide the design filtration rate at a live storage depth. Because of these discs (and the airlock cap with a one way vent) water can be impounded above the cartridges in the treatment bay.

Structures range in size from a 48” manhole to CON/SPAN sections with a 24’ x 10’ cross section built to length. In many cases smaller structures are combined with outboard storage, such as pipe, to provide the WQv storage.

The Volume StormFilter can be designed with or without an internal bypass. If peak flows to the system exceed the internal bypass, or external bypass. If peak flows to the system exceed the internal bypass, or external bypass is required, a high flow bypass is needed. The system can also be installed online or offline and uses a traffic-bearing lid.

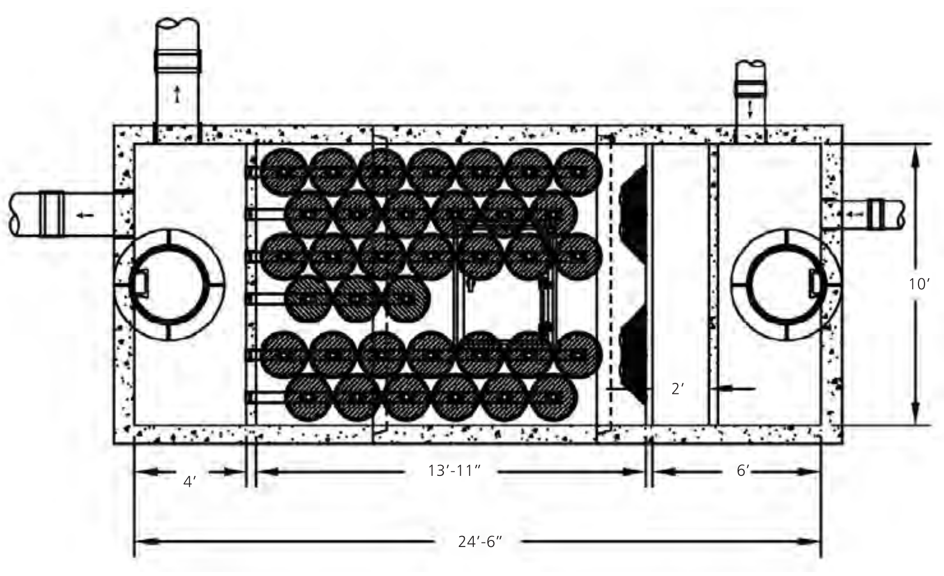
Basic Operation

The Volume StormFilter is typically configured in one of two ways.

A three bay system that incorporates internal storage for the WQv and includes: the storage bay, the filtration bay, and the outlet bay. Water first enters the storage bay (a portion of which includes dead storage) which facilitates pretreatment (gravity separation) and storage of the WQv. The stormwater is then directed into the filtration bay for full treatment and additional storage. The storage bay can be designed with a baffle to trap floatables, oils, and surface scum. Cartridges in the filtration bay treat the stormwater and control the discharge rate. Once in the filtration bay, the stormwater percolates horizontally through the media contained in the filter cartridges. After passing through the cartridge, treated water is directed to the outlet bay by an under-drain manifold where it is discharged through an outlet pipe.

A two bay, precast vault bases system similar to the Vault StormFilter where pretreatment and live storage are provided upstream.

Providing WQv storage in an outboard storage facility such as storage pipe provides the versatility to meet most footprint and elevation requirements.



Volume StormFilter

Upstream Treatment Configurations

Low Impact Design (LID) involves managing runoff close to the source using small, decentralized system. The following suite of StormFilter configurations are easily incorporated on sites where LID site design is recommended. These low-cost, lowdrop, point-of-entry systems also work well when you have a compact drainage area.

CatchBasin StormFilter

The CatchBasin StormFilter (CBSF) consists of a multi-chamber steel, concrete, or plastic catch basin unit that contains up to four StormFilter cartridges. The steel CBSF is offered both as a standard and as a deep unit.

The CBSF is installed flush with the finished grade and is applicable for small drainage areas from roadways and parking lots, and retrofit applications. It can also be fitted with an inlet pipe for roof leaders or similar applications.

The CBSF unit treats water quality design flows up to 0.20 cfs, coupled with an internal weir overflow capacity of 1.0 cfs for the standard steel and concrete units and 1.8 cfs for the deep steel units. Non-traffic rated plastic CBSF units have an internal weir overflow capacity of 0.5 cfs.

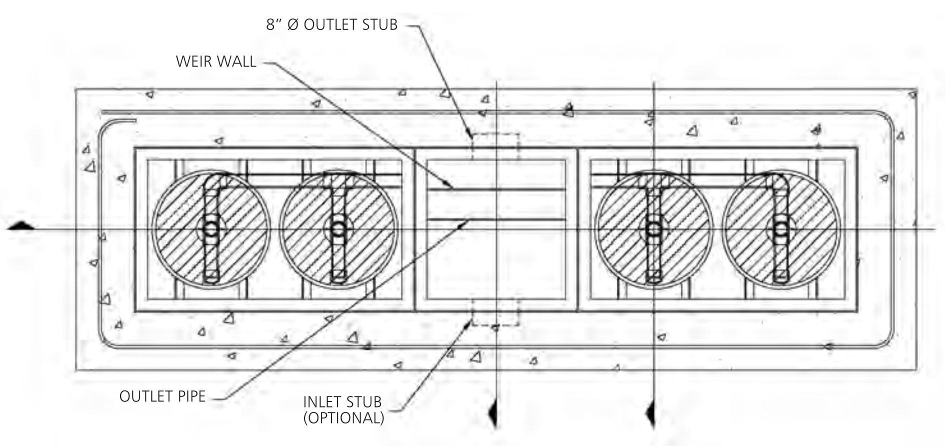
Basic Operation

The CBSF acts as the primary receiver of runoff, similar to a standard, grated catch basin. The steel and concrete CBSF units each have an H-20 rated, traffic-bearing lid that allows the filter to be installed in parking lots and take up no land area. Plastic CBSF units can be used in landscaped areas and for other non-traffic bearing applications.

The CBSF consists of a sumped inlet chamber and cartridge chamber(s). Runoff enters the sumped inlet chamber either by sheet flow from a paved surface or from an inlet pipe discharging directly to the unit. The inlet chamber's internal baffle traps debris and floating oil, and houses an overflow weir. Heavier solids settle into the deep sump, while lighter solids and soluble pollutants are directed under the baffle and into the cartridge chamber through a port between the baffle and the overflow weir. Once in the cartridge chamber, polluted water ponds and percolates horizontally through the media in the filter cartridges. Treated water collects in the cartridge's center tube from where it is directed by an under-drain manifold to the outlet pipe on the downstream side of the overflow weir and discharged.

When flows into the CBSF exceed the water quality design value, excess water spills over the overflow weir, bypassing the cartridge bay, and discharges to the outlet pipe.

The CBSF is particularly useful where small flows are being treated or for sites that are flat and have little available hydraulic head to spare. The unit is ideal for applications in which standard catch basins are to be used. Both water quality and catchment issues can be resolved with the use of the CBSF.



CatchBasin StormFilter

Curb Inlet StormFilter

The Curb Inlet StormFilter consists of a precast concrete vault ranging from 6'x8' to 8'x16' in size. These units can treat water quality design flows up to 1.2 cfs. The system is installed online and includes an internal offline overflow bypass around the filtration chamber. The internal bypass capability is based on depth of the structure. The standard bypass capacity is 15 cfs but is larger for deeper units. A traffic-bearing lid is placed underneath the median or sidewalk adjacent to the roadway.

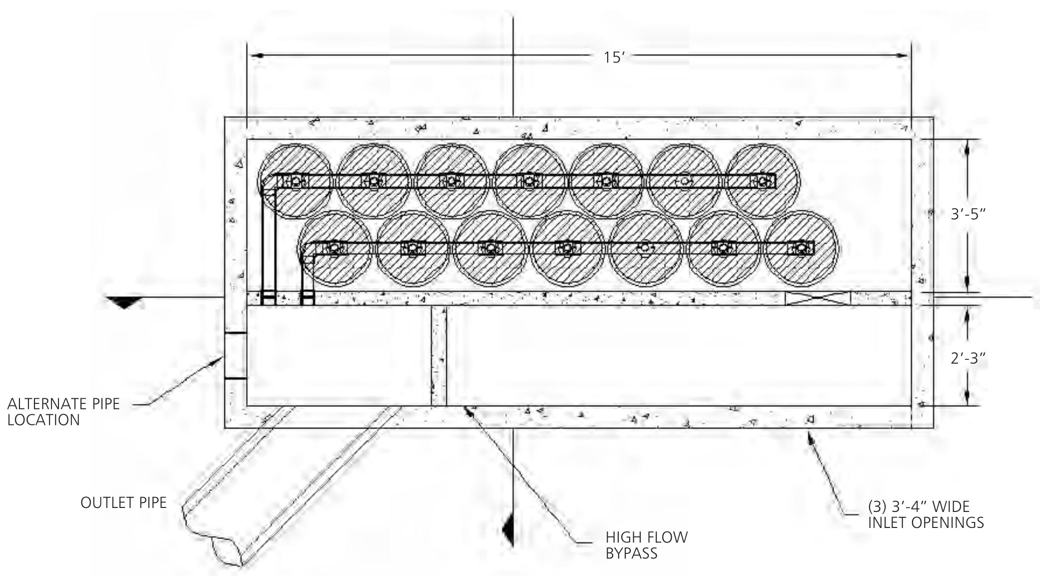
Basic Operation

The Curb Inlet StormFilter is composed of three bays: the inlet bay, the filtration bay, and the outlet bay. Stormwater enters the inlet bay through the curb inlet opening. The design flow is directed through a transfer opening to the filtration bay for full treatment.

Once in the filtration bay, the stormwater percolates horizontally through the media in the filter cartridges to the center tube. Treated water in the cartridge center tube is directed into the outlet bay by an under-drain manifold and discharged through the outlet pipe. Outlet pipes can be placed parallel, perpendicular, or up to 45° to the roadway. Overflow is directed over a weir wall between the inlet bay and the outlet bay, bypassing the filtration bay leaving accumulated pollutants undisturbed.

Curb Inlet Openings

Every Curb Inlet StormFilter is designed to meet local regulations governing the geometry of the curb inlet. This can be accomplished in two ways. One way is with an integrated face plate – the vault lid includes the face plate which is tied into the curb. Another way is with a cast-in-place face plate – the entire face plate is constructed by the contractor pouring the curb. Curb inlet openings can be 4', 7', or 10' in length.



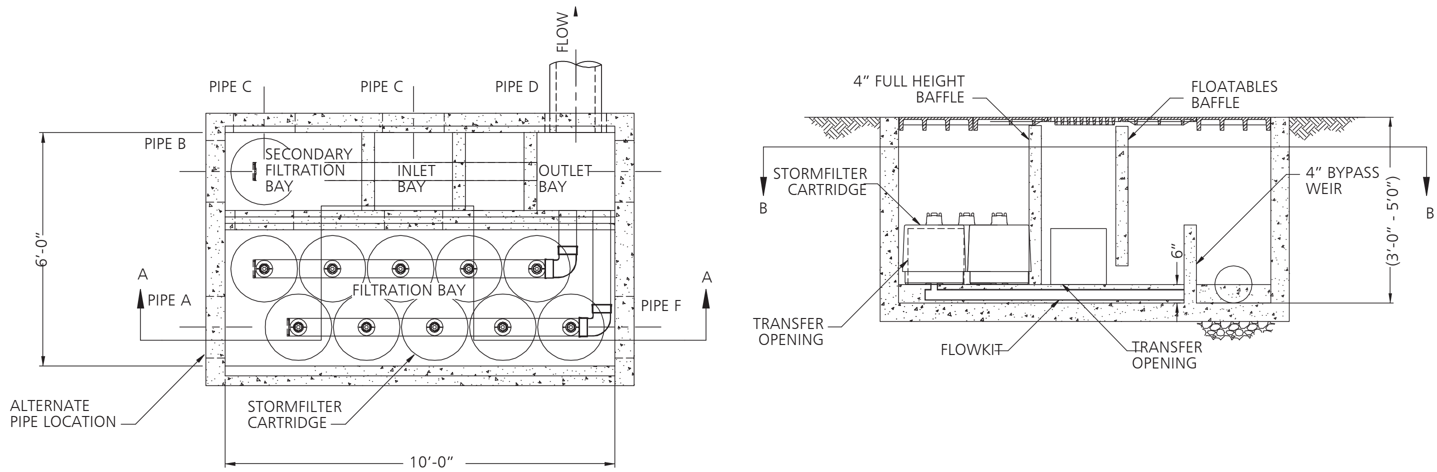
Curb Inlet StormFilter

Linear Grate StormFilter

The Linear Grate StormFilter is a precast vault that acts as the primary receiver of runoff, similar to a standard grated catch basin. The unit has H-20 rated traffic bearing lids that allow the filter to be installed under parking lots. The system consists of an inlet bay, filtration bay, and an outlet bay. Providing treatment as it enters the conveyance system reduces the overall head loss because the vertical drop from the finished grade into the conveyance system is also used to provide hydraulic pressure on the filter cartridges.

Basic Operation

Runoff enters the inlet bay by sheet flow from a paved surface or from an inlet pipe discharging directly to the unit. The inlet bay's internal baffle traps debris and floating oil and denser pollutants are directed into the filtration bay. Once in the cartridge chamber, polluted water ponds and percolates through a radial media filter cartridge. Treated water collects in the cartridge's center tube where it is directed by an underdrain manifold to the outlet pipe on the downstream side of the overflow weir. When flow rates exceed the water quality design value, excess water spills across the overflow weir, bypassing the cartridge bay and proceed directly to the outlet pipe. The integrated offline bypass ensures pollutants captured in the filtration bay are not washed downstream during peak flow events.



Linear Grate StormFilter

Grated Inlet Openings

The number of inlet grates and the size of the inlet bay are designed to capture the peak flow rates from the drainage area. The remaining area is devoted to the filtration bay and the outlet bay which are covered with removable plates for access during maintenance. The entire inlet bay, filtration bay, and outlet bay can be opened at one time allowing full access. In many cases, due to the shallow nature of the design, confined space entry is not required for maintenance.

Linear StormFilter

The Linear StormFilter consists of one or two precast concrete channels that are 10’ or 20’ in length and 2’ 9” in width.

The Linear StormFilter is installed flush with the finished grade, functioning similar to a catch basin or trench drain. The top of the unit has either covers or doors for easy access. The Linear StormFilter is typically installed online like the precast StormFilter.

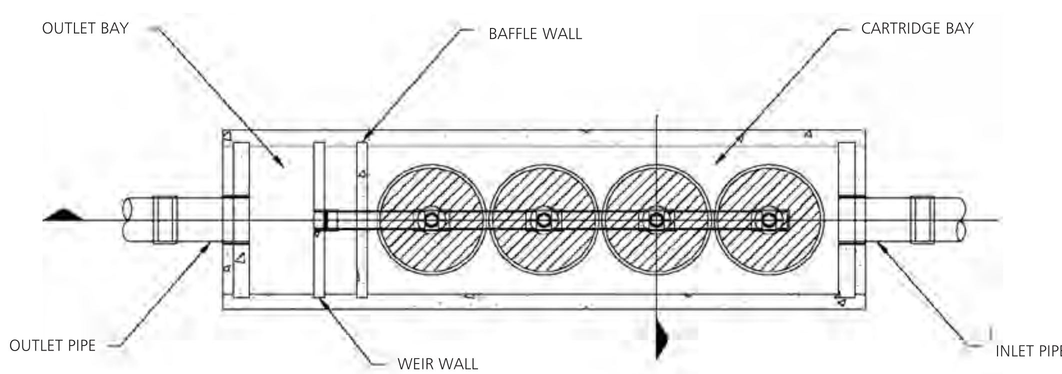
The Linear StormFilter unit treats water quality design flows up to 0.27 cfs.

Basic Operation

The Linear StormFilter can be installed either as the primary receiver of runoff, similar to a grated catch basin, or with an inlet stub and doors to receive runoff collected upstream.

The system is equipped with an internal overflow weir to ensure that there is no local flooding for storm events in excess of the design treatment flow. Maintenance costs for the unit are typically less because there are no confined space entry requirements, and access is quick and easy.

The Linear StormFilter is particularly useful where small flows are being treated or where the site is very flat and there is little available hydraulic head to spare.



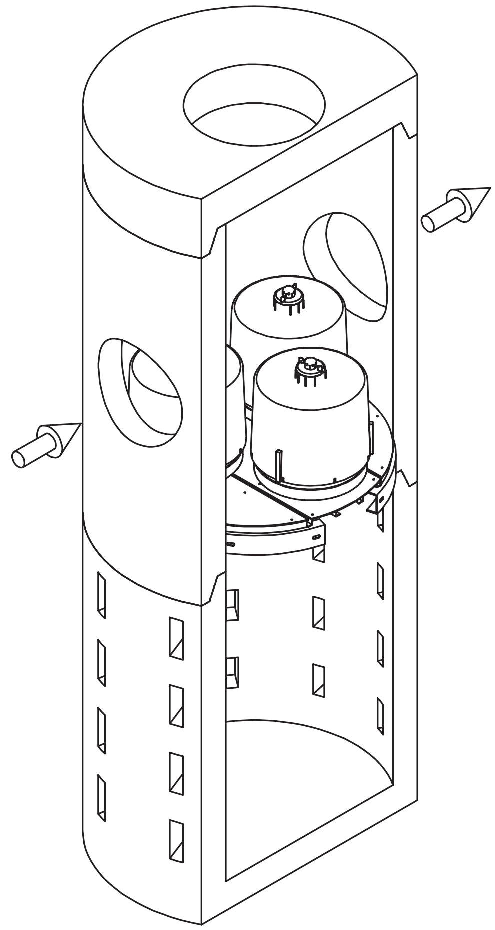
Linear StormFilter

Infiltration Configuration

Dry Well StormFilter

The Dry Well StormFilter provides treatment, infiltration and groundwater protection in a single structure. The system is designed to treat conveyed flow or sheet flow from small drainages. Multiple units can be installed to treat any size site. Because it provides treatment and infiltration in a single unit, the total number of structures and the amount of pipe required for the stormwater system are reduced.

The Dry Well StormFilter system is available in 48”, 60” and 72-” pre-cast manhole top sections that are designed to be stacked on top of dry well infiltration risers. The StormFilter portion of the unit arrives fully assembled and ready to install, including an integrated concrete deck for the StormFilter cartridges. The system can also be retrofitted into existing 48” manhole dry wells.



DryWell StormFilter

Basic Operation

Stormwater enters the dry well unit through one or more entry pipes or channels at its top. It then percolates through the media in the StormFilter cartridge to the center tube. Treated water in the cartridge center tube is discharged to the infiltration section below, and then infiltrates into the surrounding soils through a number of small exit openings at the sides and bottom.

Roof Runoff Treatment Configuration

Downspout StormFilter

The Downspout StormFilter is an aboveground configuration that can be easily integrated into existing gutter systems to eliminate pollution from rooftop runoff. It typically occupies 2.5’ x 5’ footprint, and can fit most downspout configurations and sizes. Each unit holds two StormFilter cartridges, and single- and dual-stage options are available. It treats up to 14,000 square feet of rooftop area per dual-cartridge system.

StormFilter Cartridges

There are three cartridge heights available for StormFilter systems: 27”, 18”, and Low Drop. The most economical is the 27” tall cartridge. It can treat the highest flow rate per cartridge, which creates the smallest system with the lowest installed cost. The 27” cartridge requires 3.05’ of driving head to operate. For sites with less driving head available, the 18” cartridge is the next best option. Lower flow rates per cartridge increase the footprint of the overall system but only 2.3’ of driving head is required. For sites with very limited drop, the Low Drop cartridge only requires 1.8’ of driving head.

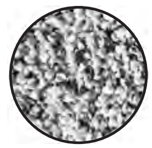
Cartridge Flow Rates

Cartridge Type	Hydraulic Drop	Treatment Capacity (gpm)	
		1 gpm/ft2	2 gpm/ft2
StormFilter 27”	3.05’	11.25	22.5
StormFilter 18”	2.30’	7.5	15
StormFilter Low Drop	1.80’	5	10

StormFilter Media

The removal of site-specific pollutants can be maximized with the variety of filtration media available. In many cases, different media types can be combined so as to target a wide spectrum of pollutants. This ability to combine and use various media types allows the system to be easily adjusted to meet ever-changing site conditions and increasingly stringent regulatory requirements.

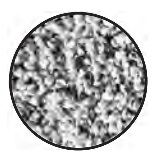
PhosphoSorb®



PhosphoSorb, a lightweight media comprised of Perlite (a heat-expanded volcanic rock) and activated alumina, removes total phosphorus (TP) by absorbing dissolved-P and filtering particulate-P simultaneously. The Perlite provides the capability to remove suspended solids while the activated alumina absorbs soluble phosphorus absorption.

PhosphoSorb is composed of a slightly finer gradation than the field proven ZPG™ (Zeolite, Perlite, Granular Activated Carbon) media and will provide equivalent - or even better - removal of suspended solids. Initial field tests have indicated an increase in the TSS removal efficiency up to 10% over the field-proven ZPG media. The StormFilter with ZPG media has already received a General Use Level Designation for basic treatment in the State of Washington.

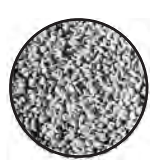
Perlite



Perlite is a natural, volcanic ash, similar in composition to glass and similar in appearance to pumice. To use perlite as a filter medium, it must first go through a heating process to yield a lightweight, multicellular, expanded form. This expanded form has a coarse texture, very low-density, high surface area, and stable, inert chemistry, all of which make perlite an excellent physical filtration medium.

Perlite has proven to be our media of choice for sediment and oil removal. The multicellular nature of expanded perlite is the key to its excellent ability to trap sediments and adsorb oil. The coarse texture of the expanded perlite creates a bed of material with a very high porosity, which allows perlite to have the highest sediment and oil storage capacity of all of the available media options.

Zeolite

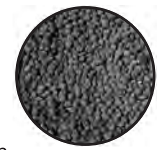


The term zeolite defines a family of both natural and synthetic, hydrous aluminosilicate materials with a highly porous mineral matrix that holds light, alkali metal cations (ideally sodium ions).

Zeolite has the ability to use a cation exchange reaction that removes other cations such as zinc, copper, lead, and ammonia from water. In the cation exchange reaction, the light metal cations in the zeolite matrix are displaced by the heavier metal cations, such as copper, in the water.

The zeolite used in our system is clinoptilolite, which has a cation exchange capacity (CEC) of approximately 100 to 220 meq/100 g. Clinoptilolite has inert characteristics that make it an excellent metals removal media option when CSF media cannot be used. It can be combined with other media such as GAC and perlite when metals are not of exclusive concern.

CSF® Leaf Media



CSF Leaf Media is a patented filtration media composed of composted deciduous leaves originating from the City of Portland, Oregon. Contech Engineered Solutions purchases the mature, stable, deciduous leaf compost and then processes it into an odorless, pelletized compost product with physical and chemical characteristics desirable for stormwater filtration.

The patented compost process creates a material with excellent flow-through characteristics and stability in water. Not only do CSF Leaf Media consist of 100% recycled, all natural materials, but it also provides good removal of sediments and excellent removal of a wide range of toxic contaminants.

CSF Leaf Media provides the multitude of beneficial water treatment properties typical of soil in a form that is compatible with the compact, modular, media-based design of the StormFilter system. In addition to the physical filtration provided by the granular nature of the CSF Leaf Media, the complex chemistry of the compost also provides chemical filtration as well.

Sediment and total nutrients are removed through physical filtration. Oil, complexed metals, and anthropogenic organic contaminants such as herbicides and pesticides are removed through adsorption, the physical partitioning of organic compounds, such as pesticides, to carbon-rich materials, such as the compost.

Soluble metals are removed by cation exchange, as well as by complexation of metal ions to the organic chelating agents present in compost. CSF Leaf Media is an excellent, cost-effective, all-purpose media that epitomizes the potential value of recycled materials.

GAC

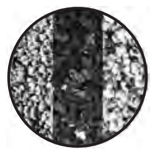
GAC (Granular Activated Carbon) is a widely accepted water filtration media used for the removal of organic compounds. It consists of pure carbon (originating from coal or charcoal) whose micro-porous structure has been enhanced through steam or acid "activation."

The high carbon content and porous nature of GAC accounts for its excellent ability to remove organic compounds through adsorption. Since adsorption is the physical partitioning of organic compounds to high carbon surfaces, the "activation" of the carbon (which creates GAC) endows it with an enormous surface area upon which adsorption can take place.

In situations where anthropogenic organic contaminants are of exclusive concern, GAC media provide the highest level of stormwater treatment compared to other available media options. However, because it is not very often the case that anthropogenic organic contaminants are of exclusive concern, GAC is usually combined with another media such as perlite or zeolite for the treatment of additional contaminants.

Combination of GAC with perlite constitutes the most cost-effective configuration, as the effectiveness of GAC is drastically reduced if it is coated with high concentrations of heavy oil or sediment, which can restrict access via surface pores to the interior of the GAC granules.

ZPG™ (Zeolite, Perlite, GAC blend)



This proprietary blend of zeolite, perlite, and granular activated carbon media is used to provide an alternative for CSF media for installations where leaf media cannot be used.

Laboratory and Field Testing

The StormFilter system is designed to meet the most stringent regulatory requirements. The field-proven performance of the StormFilter has led to hundreds of regulatory agency approvals nationwide as a standalone BMP.

The Stormwater Management StormFilter® is the first manufactured BMP to receive stand-alone approval through field testing and satisfying the total suspended solids treatment requirements in Washington and New Jersey.

Log on to www.conteches.com/stormfilter to view the following reports in full.

Field Monitoring Reports

Field Proven Performance of the StormFilter using the Technology Assessment Protocol - Ecology (TAPE) and Technology Acceptance Reciprocity Partnership (TARP) Tier II Protocol

1. Washington
   a. Washington State Department of Ecology General Use Level Designation for Basic Treatment
   b. Technical Evaluator Engineering Report (TEER). Gary Minton, Ph.D., P.E.
2. New Jersey
   a. New Jersey State Department of Environmental Protection Final Certification
   b. New Jersey Corporation for Advanced Technology (NJCAT) Field Verification Report

Laboratory Reports

Total Suspended Solids (TSS) Removal Using Different Particle Size Distributions with the Stormwater Management StormFilter.

Influences on TSS removal efficiency

Influence of analytical method, data summarization method, and particle size on total suspended solids (TSS) removal efficiency of the StormFilter

StormFilter removal efficiency with coarse/fine perlite media

Evaluation of the removal of silt loam TSS using coarse/fine perlite at 28 L/min (7.5 gpm).

StormFilter removal efficiency with ZPG media

Evaluation of the removal of SIL-CO-SIL 106 using ZPG media at 28 L/min (7.5 gpm)

StormFilter removal efficiency with coarse perlite

Evaluation of the removal of sandy loam TSS using coarse perlite at 57 L/min (15 gpm)

Support

- Drawings and specifications are available at contechstormwater.com.
- Site-specific design support is available from Contech Stormwater Design Engineers.

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

CONTECH ENGINEERED SOLUTIONS

RECYCLED PAPER

CONTECH®
ENGINEERED SOLUTIONS

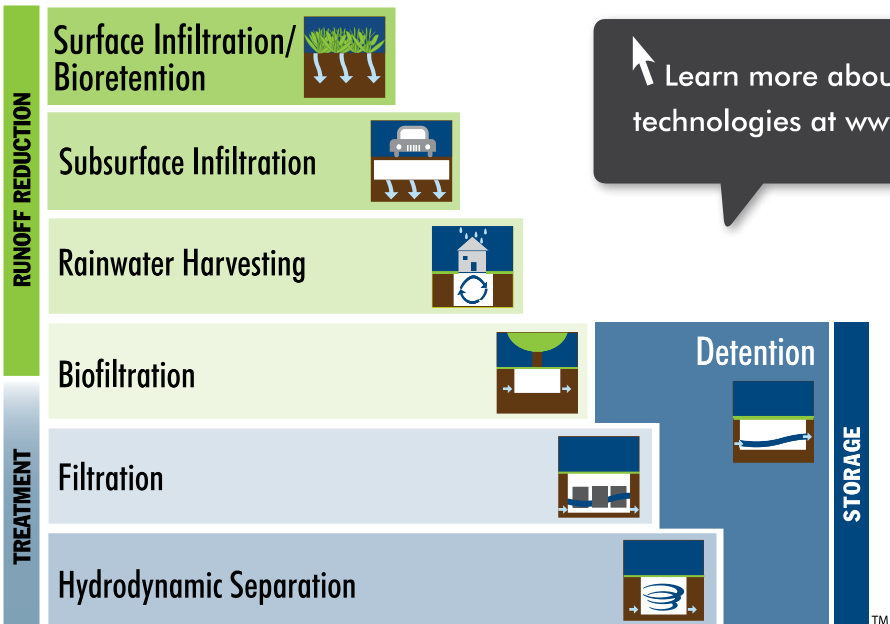
Jellyfish® Filter

Solutions Guide

Stormwater Solutions from Contech

Selecting the Right Stormwater Solution Just Got Easier...

It's simple to choose the right stormwater solution to achieve your goals with the Contech Stormwater Solutions Staircase. First, select the runoff reduction practices that are most appropriate for your site, paying particular attention to pretreatment needs. If the entire design storm cannot be retained, select a treatment best management practice (BMP) for the balance. Finally, select a detention system to address any outstanding downstream erosion.



Learn more about all of our stormwater technologies at www.ContechES.com/stormwater

Learn About the Jellyfish® Filter

Go online and watch our animation to learn how the Jellyfish Filter works. The animation also highlights important features of the Jellyfish Filter including…

- Applications
- Performance test results
- Inspection and maintenance
- Regulatory approvals

To view the Jellyfish Filter animation, visit:
www.conteches.com/jellyfish

Jellyfish® Filter

Filtration as a Stormwater Management Strategy

Stormwater regulations are increasingly calling for more robust treatment levels. In addition to the removal of suspended solids, many regulations now require best management practices to remove significant amounts of nutrients, metals, and other common pollutants found in stormwater runoff. Meeting these regulations often requires the use of a filtration solution.

Low Impact Development (LID) and Green Infrastructure (GI) are complimented by filtration solutions. Benefits of LID and GI systems include retaining runoff and aesthetic appeal. Keeping LID and GI sites free from fine sediments, oils, trash, and debris while functioning as designed can be time consuming and costly.

As a result, the practice of combining LID and GI with filtration is becoming more common. Providing a single point of maintenance promotes proper system functionality and increases the aesthetic appeal by removing unsightly trash and debris.

A Jellyfish Filter Curb Inlet pretreats runoff entering a bioretention system

The Jellyfish® Filter - Setting New Standards in Stormwater Treatment

The Jellyfish Filter is a stormwater quality treatment technology featuring high surface area and high flow rate membrane filtration at low driving head. By incorporating pretreatment with light-weight membrane filtration, the Jellyfish Filter removes floatables, trash, oil, debris, TSS, fine silt-sized particles, and a high percentage of particulate-bound pollutants; including phosphorus and nitrogen, metals and hydrocarbons.

The high surface area membrane cartridges, combined with up flow hydraulics, frequent backwashing, and rinsable/reusable cartridges ensures long-lasting performance.

The Jellyfish Filter.

Jellyfish® Filter Features and Benefits

FEATURES	BENEFITS
1. High surface area, high flow rate membrane filtration	1. Long-lasting and effective stormwater treatment
2. Highest design treatment flow rate per cartridge (up to 80 gpm (5 L/S)	2. Compact system with a small footprint, lower construction cost
3. Low driving head (typically 18 inches (457 mm) or less)	3. Design Flexibility, lower construction cost
4. Lightweight cartridges with passive backwash	4. Easy maintenance and low life-cycle cost
5. 3rd party verified field performance per TARP Tier II protocol	5. Superior pollutant capture with confidence

Jellyfish® Filter Applications

- Urban development
- Highways, airports, seaports, and military installations
- Commercial and residential development, infill and redevelopment, and stormwater quality retrofit applications
- Pretreatment for Low Impact Development (LID), Green Infrastructure (GI), infiltration, and rainwater harvesting and reuse systems
- Industrial sites

A Jellyfish Filter pretreats a bioretention/ bioswale system at a commercial site in Ontario, Canada.

A catch basin Jellyfish Filter is installed in a commercial development in Virginia.

A Jellyfish Filter provides treatment at an Industrial Park in Lake Tahoe, Nevada.

Jellyfish® Filter Field Performance Test Results

POLLUTANT OF CONCERN	% REMOVAL
Total Trash	99%
Total Suspended Solids (TSS)	89%
Total Phosphorus (TP)	59%
Total Nitrogen (TN)	51%
Total Copper (TCu)	>80%
Total Zinc (TZn)	>50%
Turbidity (NTU)	<15%

Sources:
TARP II Field Study – 2012 JF 4-2-1 Configuration
MRDC Floatables Testing – 2008 JF6-6-1 Configuration

The pleated tentacles of the Jellyfish Filter provide a large surface area for pollutant removal.

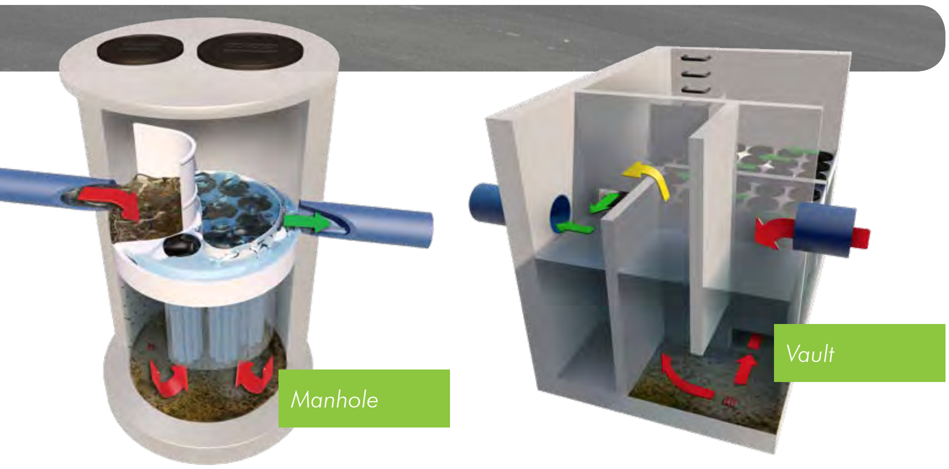
Jellyfish® Filter Approvals

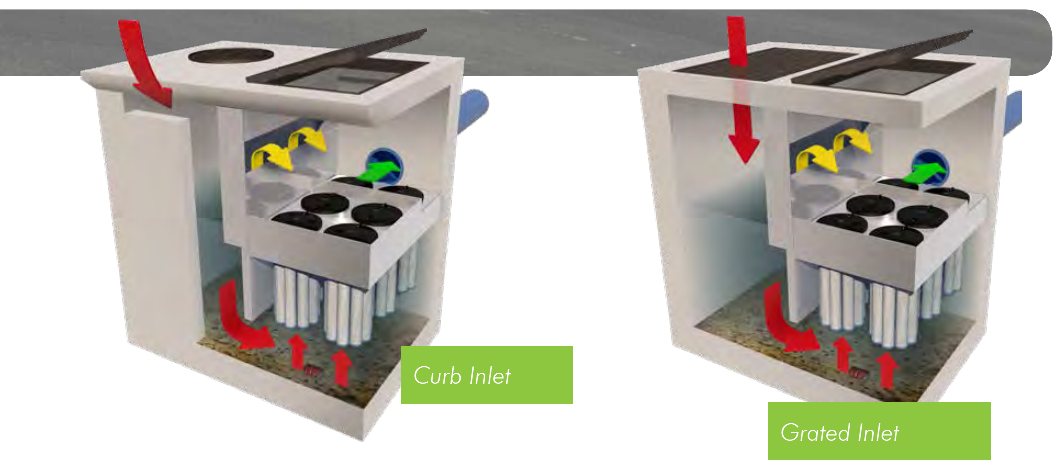
The Jellyfish Filter is approved through numerous state and federal verification programs, including:

- New Jersey Corporation for Advanced Technology (NJCAT) – Field Performance Verification per TARP Tier II Protocol
- Washington State Department of Ecology (TAPE –CULD)
- Maryland Department of the Environment (MD DOE)
- Texas Commission on Environmental Quality (TCEQ)
- Virginia Department of Environmental Quality (VA DEQ)
- New York Department of Environmental Conservation (DEC)
- City of Denver
- Los Angeles County
- Canada ISO 14034 Environmental Management – Environmental Technology Verification (ETV)
- Ontario Ministry of the Environment – New Environmental Technology Evaluation (NETE) – Certification

Jellyfish® Filter Configurations

The Jellyfish Filter is available in a variety of configurations. Typically, 18 inches (457 mm) of driving head is designed into the system. For low drop sites, the designed driving head can be less.





Lightweight Jellyfish Filter Configurations

Custom configurations include Jellyfish Filter tanks made from fiberglass for site specific applications.

A Jellyfish Filter was constructed from fiberglass to reduce the weight of the system, allowing for a suspended installation above an underground parking structure. The reduced weight eliminated the need for structural changes, and suspending the Jellyfish resulted in no loss of parking space, maximizing real-estate value.

Jellyfish® Filter Maintenance

Inspection and maintenance activities for the Jellyfish Filter typically include:

- Visual inspection of deck, cartridge lids, and maintenance access wall.
- Vacuum extraction of oil, floatable trash/debris, and sediment from manhole sump.
- External rinsing and re-installing of filter cartridges.
- Replacement of filter cartridge tentacles as needed. Cartridge replacement intervals vary by site; replacement is anticipated every 2-5 years.

The Jellyfish Filter tentacle is light and easy to clean.

Jellyfish® Filter Inspection and Maintenance Video

Inspecting and maintaining the Jellyfish Filter is easier than you may think. Watch the Jellyfish inspection and maintenance video at **www.ContechES.com/jellyfish**

LEARN MORE

- Access project profiles, photos, videos and more online at **www.ContechES.com/jellyfish**

CONNECT WITH US

- Call us at 800-338-1122
- Contact your local rep at **www.ContechES.com/localresources**

START A PROJECT

- Submit your system requirements on our product Design Worksheet **www.ContechES.com/start-a-project**

USE OUR ONLINE TOOLS

- Low Impact Development Site Planner **www.ContechES.com/LIDsiteplanner**

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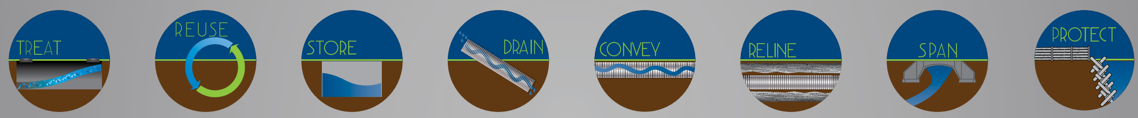
COMPLETE SITE SOLUTIONS



TREATMENT SOLUTIONS

Helping to satisfy stormwater management requirements on land development projects

- Biofiltration/Bioretention
- Stormwater Treatment
- Detention/Infiltration
- Rainwater Harvesting

PIPE SOLUTIONS

Meeting project needs for durability, hydraulics, corrosion resistance, and stiffness

- Corrugated Metal Pipe (CMP)
- Steel Reinforced Polyethylene (SRPE)
- High Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)

STRUCTURES SOLUTIONS

Providing innovative options and support for crossings, culverts, and bridges

- Plate, Precast & Truss Bridges
- Hard Armor
- Retaining Walls
- Tunnel Liner Plate

CONTECH® ENGINEERED SOLUTIONS

Get Social With Us!

Jellyfish Brochure 3M 10/16 (PDF - 07/18)

Appendix H:
Meeting Minutes

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Metro

HDR

Meeting Minutes

Project: **Link US**

Subject: LABOE Coordination Meeting No. 3

Date: Wednesday, September 21, 2016

Location: BOE Offices: 1149 South Broadway; 10th floor, Conference Room B

Attendees:
Ammar Eltawil (LABOE)
Allen Wang (LABOE)
Benjamin Moore (LABOE)
Eduardo Cervantes (Metro)
Vincent Chio (Metro)
Marc Cooley (HDR)
Myles Harrold (HDR)
Furong Zhen (HDR)
Patrick Wong (W2)
Jonathan Lim (W2)

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1. Introductions and Meeting Purpose

Attendees introduced themselves and identified their agency affiliations or roles on the project. Attendees included representatives from the Link US project team (HDR, W2), LA Metro, and LABOE

The intent of this meeting was to meet with LABOE's LID specialist, Ammar Eltawil, to present the team's approach to addressing the City's LID requirements for treating onsite stormwater and to discuss the applicability of these requirements for addressing offsite stormwater associated with the new run through tracks structure and local street reconstruction.

2. Project Overview

HDR provided a brief history and overview of the Link US Project:

- HDR provided a general overview of the various components of the project, including the run through tracks south of Los Angeles Union Station (LAUS), the new passenger concourse under the station yard, and the proposed reconstruction/raising of the tracks within the throat to accommodate both the concourse and the crossing of the run through tracks structure over the El Monte Busway. HDR indicated that the project has evolved since its original inception in the mid 2000's to include the accommodation of California High Speed Rail (HSR) tracks and platforms at LAUS, and the construction of the proposed world class passenger concourse under the rail yard as envisioned as part of the LAUS Master Plan.
- HDR presented an exhibit showing the proposed regional rail and HSR track alignments associated with the combined structure option. With this option, the HSR tracks and platforms would be constructed as part of the Link US Project, with the tracks being supported on a common structure south of US-101. The structure in this case would be located south of Commercial Street and would require the full

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acquisition of the properties along the south side of the street between Garey and Center Streets.

3. Work to be Completed as Part of Current Contract

HDR indicated that their current contract with Metro for the Link US project includes the following major project elements:

- Preparation of EIR/EIS for the proposed project
- Preparation of preliminary engineering/architectural plans and Design-Build procurement documents for the proposed project.

The Draft EIR/EIS is scheduled to be circulated in April of 2017, with certification of the environmental document planned for November of 2017. The preliminary design package is estimated to be complete by April of 2018, with work to be completed as part of the Design-Build contract to be initiated in early 2019.

4. Proposed Onsite Improvements at LAUS and Throat Area

HDR provided an overview of the analysis completed to determine the most appropriate approach for treating onsite stormwater runoff at the proposed station yard and throat area. HDR noted that the entire station yard and throat area was assumed to be impervious for the purpose of this analysis as the tracks in this area will either be supported on the concourse roof structure or on cellular concrete fill. The limits of the onsite area were assumed to extend from US-101 to the south to Vignes Street to the north. The following were key items related to this discussion:

- Passenger concourse and egress plaza
  - The existing ridge conditions within the existing Station Yard were used to divide the site into three on-site tributary areas. The total on-site disturbed on-site area is approximately 23 acres.

- Proposed LEED certification and applicability of City LID criteria
  - The stormwater system for Link US must conform to LEED Silver requirements. Further analysis is needed to determine if the City of Los Angeles LID requirements will also meet LEED credit requirements.

- Overall goals related to water quality and stormwater treatment
  - The BMP system will comply with the Municipal Storm Water Permit issued by the California Regional Water Quality Board. A pre-treatment system is proposed to remove pollutants before stormwater enters into a cistern system.

- Potential Tier 1 and Tier 2 BMP’s considered
  - According the City of Los Angeles LID Manual, the following is the priority order for implementing BMPs:

        - Tier 1: Infiltrate
        - Tier 2: Capture and Use
        - Tier 3: Biofiltration
    - Tier 1 is not feasible because infiltration cannot occur underneath railyard track or within 25 feet of structures. Also, based on preliminary geotechnical investigation, the water table, soil condition, and hazardous material are not favorable for infiltration.
    - Therefore, Tier 2 is proposed.

- Proposed cisterns and their location, size and function
    - Three cistern locations are proposed. One for each tributary area. Two of the cisterns are located west of the yard track (Cisterns #2 and #3), while the other is currently placed underneath the tracks (Cistern #1). Cistern #1 may be relocated to another location within the tributary area.
    - Cisterns will be sized at a minimum to meet LID requirements, 85^{th} percentile storm (1.0 inch rain depth for project site).
    - Stormwater from the site will flow into a water quality unit for pre-treatment prior to discharging into the cistern for storage. A mechanical skid unit will manage the distribution of the captured stormwater for re-use; i.e. for irrigation. If non-potable uses are pursued, then a post treatment (filter and UV system) will be required as well as clearance from LA County Department of Public Health.
    - The water balance analysis is ongoing and will continue to be updated as the project progresses in its design. The current program is to collect stormwater and HVAC condensate to the cistern, and supply the landscape irrigation and toilet demands.
    - Based on this meeting, the City of Los Angeles (BOS) concurs with the concept of a cistern as an on-site BMP. There will be a follow-up meeting next week to discuss cistern and drainage in more detail.

5. Proposed Local Street Improvements

HDR and BOE discussed the applicability of the City's LID/green street requirements as they related to the offsite work south of LAUS within City of LA jurisdiction, which includes the new run-through track viaduct structure and the associated local street modifications. The following items of note were discussed as part of this agenda item:

- LABOE feels that based on current City policy, Metro would be treated as a developer with regard to the need to meet the City's LID guidelines for the local street reconstruction included as part of the Link US Project. Meeting the City's LID guidelines would involve the implementation and maintenance of City approved stormwater treatment BMP's as part of the street reconstruction. Metro disagreed with the City's position with regard to the maintenance and stated that they should not be responsible for the maintenance costs of the BMP's, which would be in perpetuity. Metro cited the agreement between the City of LA and Metro that was adopted as part of the Crenshaw LRT project for the construction and maintenance of the stormwater treatment BMP's included as part of the Crenshaw Boulevard street reconstruction. This agreement stipulates that Metro will be responsible for the cost of the maintenance of the BMP's constructed as part of the project for a five year period, after which maintenance responsibilities will be relinquished to the City via a mutually agreed upon approach between Metro and the City.

- HDR noted that conventional BMP's involving infiltration such as curb cuts/planter boxes would not be applicable for use along the Commercial Street corridor due to the likelihood for soil contamination, existing soil impermeability, and high groundwater.
- Metro suggested considering an approach for treating project runoff that takes advantage one of the adjacent acquired parcels which could be converted into a pocket park or some other public space as part of the project. A stormwater treatment BMP could be incorporated into the design of a pocket park or other public space where stormwater is captured and reused to provide for landscaping irrigation. Another option would be to incorporate some sort of biofiltration BMP into the design of the park's landscaping elements. HDR agreed to explore this approach.

6. Next Steps

The group agreed to switch the day/time of the planned biweekly coordination meetings with BOE staff to alternate Wednesday afternoons so that Ammar can participate. The next meeting was scheduled for Wednesday September 28th.

Meeting Action Item Summary

No.	Action Item	Responsibility	Due Date
1	Metro and City of LA to continue discussions regarding maintenance cost responsibilities for any offsite storwmater BMP's included as part of Link US Project.	Metro/BOE	
2	HDR to consider potential BMP's for offsite stormwater treatment that could be integrated into potential pocket parks or other uses that could be considered for properties to be acquired along Commercial Street corridor?	HDR	