11.9 Drainage and Water Quality Study

DRAINAGE AND WATER QUALITY ASSESSMENT

BROOKFIELD RESIDENTIAL LINCOLN

Whittier, California

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1.0 INTRODUCTION

1.1 PROJECT INTRODUCTION AND BACKGROUND

The proposed Lincoln project plans to develop a 73.6-acre mixed-use development, comprised of commercial property, mixed multi-family residential, parks/open space, and roadways as reflected in the Tentative Tract Map. Additionally, integration of parks, open space and other amenities are included to promote healthy lifestyles. For the purposes of this report, the project area referenced is the tributary drainage area of the site, 76.9-acre.

The 76.9-acre site located at 11850 Whittier Blvd within the City of Whittier, County of Los Angeles. The project site previously served as the Fred C. Nelles Youth Correctional Facility and was closed by the State of California in June 2004. The site sits southerly of the Whittier Blvd & Sorenson Avenue intersection and is surrounded by single family residential to the south west, and commercial and industrial land usages to the south east.

Tall barbwire fencing exists along the perimeter of the site due to its former use as a correctional facility. Within its walls of the former correctional facility, the impervious area is approximately 40% with the remaining pervious area mainly consisting of grass and scattered trees. Topographically, the site is relatively flat with a moderate slope directed southwesterly.

1.2 PURPOSE OF THIS REPORT

The purpose of this Preliminary Drainage Report is to analyze the 25-year and 50-year storm events for the proposed condition. Outcomes of the analysis will facilitate the design of a drainage system to adequately convey storm runoff through the site without adversely impacting the proposed development surrounding areas, neighboring properties, and/or existing storm drain facilities. Additionally, information provided within this report will be used to support preparation of s Specific Plan and Environmental Impact Report (EIR).

The report also includes a discussion of the recently updated MS4 stormwater requirements for Los Angeles County and the preliminary approach to water quality compliance.

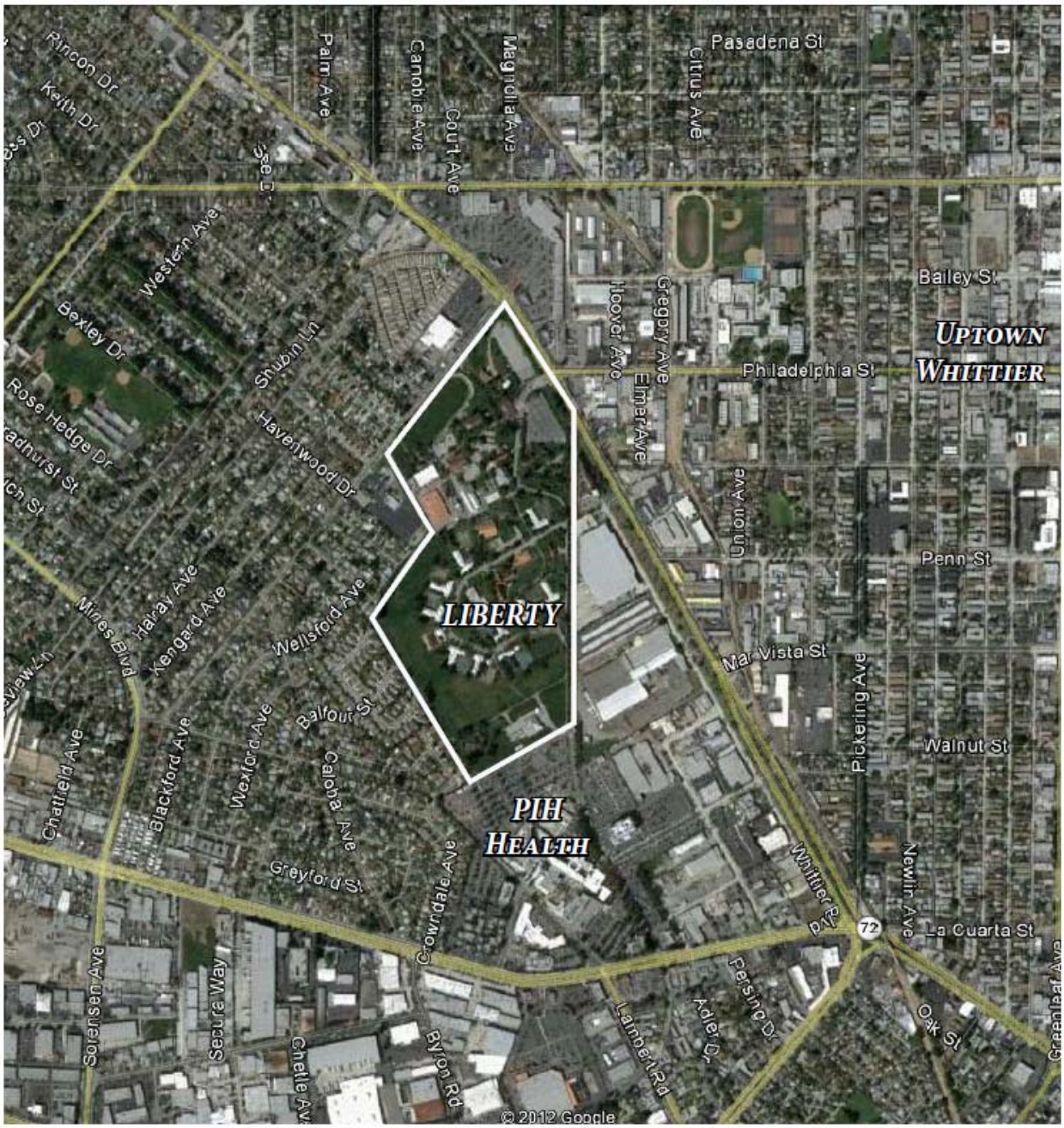
1.3 REFERENCES

The following references were used to evaluate hydrologic conditions and water quality requirements:

- Los Angeles County Hydrology Manual (January 2006)
- MS4 Discharges within the Coastal Watersheds of Los Angeles County, Order No. R4-2012-0175 NPDES Permit No. CAS004001, CA Regional Water Quality Control Board, Los Angeles Region (Adopted November 8, 2012; Effective as of December 28, 2012)

1.4 PROJECT SITE LOCATION MAP

The Project site is identified in the location map shown below.



2.0 EXISTING TOPOGRAPHIC & HYDROLOGIC CONDITIONS

2.1 EXISTING TOPOGRAPHY

As determined from site visits, aerial photos and topographic maps, the site slopes towards the south west direction at approximately 2.5-3.5%. Generally the site currently sits above the neighboring residential community and slightly below Whittier Blvd.

2.2 EXISTING DRAINAGE PATTERN

The existing drainage pattern is consistent with existing topography, which conveys storm flows westerly. Flows are routed around existing buildings via streets, walkways, and existing storm drain facilities, which ultimately convey storm flows to a public facility at the south west portion of the site.

2.3 EXISTING STORM DRAIN FACILITIES

As previously stated, storm drain facilities convey storm flows to a public facility at the south west portion of the site. Localized inlets exist throughout the site to intercept storm water runoff and convey flows through a series of pipe networks. Storm flows exit the site westerly via a publicly maintained 36" RCP located approximately 500 feet north of the south corner of the site. The existing 36" storm drain meanders through the adjacent residential neighborhood westerly in Rose Hedge Drive, southerly within Appledale Avenue, then easterly in Washington Boulevard and ultimately to Coyote Creek (See Appendix H).

Based upon State of California Storm Drain Plans dated March 1962 (Appendix H) and a friction slope calculation (Appendix E), the existing 36" RCP has a capacity of approximately 85 cfs.

3.0 HYDROLOGY

3.1 STORM FREQUENCY

Per Los Angeles County's requirements, the design storm for this project is a 25-year storm event. The 50-year event has also been modeled for this project and included within this study.

3.2 METHODOLOGY

This study was prepared using the TC Calculator in conformance with the Los Angeles County Hydrology Manual. Conservative assumptions have been made for this level of preliminary hydrology. Changes in flow rates and volumes are provided for comparison purposes along with conceptual routing calculations.

The TC Calculator and Hydraulic Toolbox software were used to determine discharges within the Study Area per LA County Hydrology procedures (Appendix C).

3.3 EXISTING CONDITION HYDROLOGY

A hydrology study was prepared for the existing condition and analyzed for a 25-year storm event. Within the existing site 76.9 acre site, approximately 72.9 acres are tributary to the previously described existing 36" RCP. The reaming 4.0 acres includes the 0.4 acre parkway westerly of the site and Area F (3.6 acres), which flows towards Sorenson Avenue is not tributary to the 36" RCP (see Existing Condition Hydrology Map). The 72.9 acres of tributary area has an impervious percentage of approximately 40%, which results in approximately 141.7 cfs of run off. Area F will be designed to route storm flows towards the existing 36" RCP in the proposed condition.

Majority of storm flows from the existing commercial site to the northeast and south of the project will be intercepted by existing catch basins within the entrance/exit driveways of the commercial site and within Whittier Blvd prior to reaching the project site. A small portion of the landscaped area, approximately 5' strip behind the parking lot pavement to the northeast and south, may convey minor remainder flows that do no infiltrate across the property line onto the project site. To the northeast, the commercial site is enclosed by a private gate and is difficult to determine if the landscaped area is picked up by a private area drain system. This runoff from these landscaped areas are minor and do not propose an issue for the ultimate condition.

The hydrology calculations performed within this study demonstrates that the existing condition runoff exceeds the capacity of the existing 36" storm drain pipe. The existing condition 25 & 50 year flow rates have been provided on the existing condition hydrology map included within Appendix A.

3.4 PROPOSED CONDITION HYDROLOGY

The proposed condition will consist of a mixed use development including the integration of parks, open space, and dense landscaped areas. The proposed impervious area based upon a conceptual site plan will make up approximately 76.5% of the overall project site (See Appendix A Proposed Condition Hydrology Map). Similar to existing conditions, the proposed condition will be tributary to the existing 36" storm drain located approximately 500 feet north of the south corner of the property. With an increase of impervious area within the proposed condition, the study shows an increase in storm water runoff as compared to the existing condition. However, based upon the capacity calculations for the existing 36" RCP provided in Section 2.3, the project will still require mitigation for peak flows.

For this level of conceptual hydrology, two models were prepared for each storm event to quantify a difference in flow rates between existing and proposed conditions. The first model uses LA County TC Calculator to determine 25-year and 50-year storm event flow rates for various sub areas within the project site. The total estimated peak flow from each of these events resulted in an unmitigated flow well above the 85 cfs maximum capacity of the existing 36" RCP.

The second model proposes a detention system to mitigate flows. TC Calculator determines 25-year and 50-year storm event flow rates for areas upstream and downstream of the proposed detention basin. All upstream flows are routed through the proposed detention system, resulting in a reduced and controlled outflow. This reduced basin flow then confluences with areas downstream of the proposed detention system resulting in an overall mitigated flow rate at the existing 36" storm drain pipe. The following table demonstrates the flows to the existing 36" RCP for the various conditions.

Routing Calculations are provided in Appendix E.

	Storm event	Area (ac)	Flow (cfs)		Storm event	Area (ac)	Flow (cfs)
Existing	25	72.9	141.7	Existing	50	72.9	168.5
Proposed	25	76.9	149.2	Proposed	50	76.9	178.2
Mitigated	25	76.9	**71.7**	Mitigated	50	76.9	**83.1**

Within the existing condition, the 0.4 acre parkway westerly of the site and the 3.6 acre Area F drains directly to Sorensen Avenue. The two areas are not tributary to the existing 36" RCP.

4.0 PROPOSED STORM DRAIN FACILITIES

The proposed onsite storm drain facilities will consist of a combined low flow water quality and peak flow conveyance system. A low flow water quality system will intercept the low flows and provide water quality treatment in order to meet the LA County LID Ordinance (further described in Section 5.0). A peak flow storm drain storm drain system will provide peak flow reduction via a detention system in order to meet the capacity requirements of the existing 36" RCP. In this conceptual design stage, both systems have been integrated to function together as demonstrated within the storm water exhibit (See Appendix B).

As shown in the proposed condition hydrology map, a detention system is proposed within the park site, Area A10. Catch Basin inlets will intercept storm flows from the upstream areas of the park site and convey flows through a network of storm drain pipes into the detention system. The detention system will serve two primary functions. It will detain low flows for controlling discharge to water quality facilities and provide peak flow detention to meet the downstream requirements. Based on the preliminary calculations, the detention system will be sized to accommodate approximately 11ac-ft of detention to reduce peak flows down to the allowable discharge limit of the existing 36" RCP, for the 25 & 50 year storm event. Approximately 2.53 ac-ft of the detention basin will be used for low flow water quality infiltration.

No additional flow attenuation measures are proposed downstream of this park site. Therefore, the single detention facility within the park will overcompensate for flow reduction for upstream areas and combine with unmitigated flows downstream of the facility to meet the allowable capacity of the existing downstream system. To summarize, approximately 65 cfs is conveyed to the proposed detention system which will release a maximum of 25 cfs during a 50 year storm event. This flow joins the downstream portion of the site combining for a total

of approximately 83 cfs which is less than the maximum capacity of the existing 36" RCP (see Appendix H).

The alignment, location, and estimated sizes of the proposed storm drain facilities are provided within the conceptual storm drain included in Appendix B. All onsite peak flow storm drain facilities within the public right of way will be publically owned and maintained.

With the proposed storm drain system provided within this report, the existing facilities will continue to function as they do currently without adverse impact to the downstream reaches.

It is important to note that an alternative scenario was analyzed for the proposed storm drain facilities, which removes the commercial area of the site out of the study area. This alternative assumes that the commercial site will be responsible for its own detention and water quality mitigation. A memo is provided in Appendix I to summarize the findings.

5.0 MS4 STORMWATER QUALITY DESIGN

This section covers the post-construction operations on the Lincoln mixed-use development, in the City of Whittier, California. It has been developed as required under State Water Resources Control Board (SWRCB) Municipal NPDES Stormwater Permit for the County of Los Angeles and the Incorporated Cities of Los Angeles County (Order No. R4-2012-0175), and in accordance with good engineering practices.

This Municipal Separate Storm Sewer (MS4) Plan will identify, at a minimum, the project performance criteria specified in the Los Angeles County MS4 Permit, which details implementation of Best Management Practices (BMPs) that mitigate the project's Stormwater Quality Design Volume (SWQDv) defined as the runoff from the 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map. Based on the isohyetal map (http://dpw.lacounty.gov/wrd/hydrologygis/), the project's 85th percentile, 24-hour rain event is 1.0 inch. BMPs selected shall rely on infiltration, bioretention, rainfall harvest and use, and/or biofiltration, as feasible.

5.1. EXISTING SITE DESCRIPTION

The proposed Lincoln mixed-use project site is an approximate 76.9-acre parcel located within the City of Whittier, CA 90606. The project site is bounded by the intersection of Whittier Blvd. and Sorensen Ave. to the north, Presbyterian Intercommunity Hospital to the south, commercial warehouses to the east, and residential neighborhoods to the west. The project site formerly served as the Fred C. Nelles Youth Correctional Facility. Topographically, the site is relatively flat and slopes southwesterly at approximately 2.5% to 3.5% grade.

WATERSHED

The subject property lies within the lower portion of the San Gabriel River Watershed. The watershed drains into the San Gabriel River from the San Gabriel Mountains flowing 58 miles south until its confluence with the Pacific Ocean. Major tributaries to the San Gabriel River

include Walnut Creek, San Jose Creek, Coyote Creek, and numerous storm drains entering from the 19 cities that the San Gabriel River passes through.

The proposed project indirectly discharges to Coyote Creek via the Municipal Separate Storm Sewer (MS4) and ultimately to the San Gabriel River approximately 12 miles downstream, prior to its confluence with the Pacific Ocean 3.5 miles further downstream. Coyote Creek is 303(d) listed as impaired for the following constituents: ammonia, copper, diazinon, bacteria, lead, pH, and toxicity. San Gabriel River Reach 1 is listed as impaired for bacteria and pH, while its estuary is impaired for copper, dioxin, nickel, and dissolved oxygen. TMDLs for the above-listed constituents are scheduled for adoption between the years 2019 and 2021. To date, a Metals TMDL has been established for the San Gabriel River since 2006, which the proposed project is subject to.

SOILS AND GROUNDWATER CONDITIONS

Based on the Geotechnical Report furnished by LGC Geotechnical, Inc. on February 25, 2005, the field exploration generally indicated fine-grained sediments consisting predominantly of layered clay, silt, sandy silt, and minor amounts of silty sand. Infiltration tests have not been performed at the project site and will need to be performed at a later phase in the project's development, in order to determine infiltration BMP feasibility. Therefore, infiltration BMP feasibility has not been ruled out for the proposed project. The northern half of the project site is comprised of Soil Group No. 016 soils (Yolo Loam), while the southern half of the project is comprised of Soil Group No. 017 (Yolo Clay Loam), according to the Los Angeles County Department of Public Works web-based Hydrology Map (http://dpw.lacounty.gov/wrd/hydrologygis/) (See Appendix D). Yolo soils are well-drained, with slow to medium runoff and moderate permeability.

Groundwater was not encountered to the depths explored, which ranged from 26.5 to 51.5 feet below ground surface (bgs). Historic high groundwater is estimated on the order of 30 to 50 feet bgs, with the shallowest levels recorded along the southwest portion of the site (CDMG, 1998). There does not appear to be any groundwater constraints for infiltration BMPs.

EXISTING DRAINAGE

The existing drainage pattern is consistent with the existing topography, which conveys storm flows westerly. Flows are routed around existing buildings via streets, walkways, and existing storm drain facilities, which ultimately convey storm flows to a public facility at the south west portion of the site. Localized inlets are scattered throughout the site which intercept storm water runoff and convey flows through a series of pipe networks. See Section 2.3 for existing storm drain facilities. Storm flows exit the site via a publicly maintained 36" RCP directed westerly located approximately 500 feet north of the southwest property corner. The existing 36" storm drain meanders through the adjacent residential neighborhood, westerly in Rose Hedge Drive, southerly within Appledale Avenue, then easterly in Washington Boulevard and ultimately to Coyote Creek (See Appendix H).

Prior to construction, approximately 40% of the site is impervious. Based on the following formula, the runoff coefficient for the 76.9-acre property is 0.42. See Appendix F for a

breakdown of imperviousness for each existing drainage subarea (Lincoln Tc Results – LID worksheet).

$C_D = (0.9 \times Imp.) + [(1.0 - Imp.) \times C_U]$

Where:

C_D = Developed Runoff Coefficient
C_U = Undeveloped Runoff Coefficient = 0.1
Imp. = imperviousness

5.2. PROPOSED SITE DESCRIPTION

The proposed Lincoln project plans to develop a 76.9-acre mixed-use development, comprised of approximately 21.8 acres of commercial property, 50.6 acres of mixed multi-family residential, and 4.5 acres of parks/open space. Based on these proposed land uses, impervious percentages were derived using the Los Angeles County Department of Public Works Hydrology Manual (Water Resources Division, January 2006) Appendix D. The 21.8 acre commercial development has been identified as "Retail Centers (Non-Strip with Contiguous Interconnected Off-Street)" which is considered 96% impervious (Land Use Code 1222). The 50.6-acre residential portion of the project has been designated "Mixed Multi-Family Residential" with a 74% imperviousness (Land Use Code 1121). The 4.5 acres of open space is identified as "Developed Local Parks and Recreation" with 10% impervious (Land Use Code 1821). Street parking is anticipated for the project site, as well as other parking facilities, though precise composition has not been determined at this stage in the project's development. Based on these values, overall, the project will result in a runoff coefficient of 0.71, as an estimated 76.5% of the property will be impervious. For the purposes of this report, a 0.71 runoff coefficient will be used for MS4 Treatment BMP and LID calculations.

PROPOSED DRAINAGE

Under proposed conditions, the Lincoln project will be divided into two primary Drainage Management Areas (DMAs) designated A and B for water quality purposes. The northern 42.2 acre portion of the project site comprises DMA A. The remaining 34.7 acre southern half comprises DMA B. The conceptual LID BMP Exhibit provided within Appendix G depicts the DMAs and their sub-drainages. DMA A is proposed to drain southerly via curb and gutter flow and collected by catch basins to the open space/park area at the center of the property (within drainage management area A8), where low flow storm water runoff will be treated by LID BMP(s). Similarly to DMA A, storm water runoff within DMA B will be conveyed southerly via curb and gutter flow to catch basin inlets located throughout. Rather than a large centralized LID BMP to treat storm water runoff as in DMA A, however, LID BMPs will be dispersed throughout DMA B. This is the current concept proposed. It should be noted that should future design changes to the Lincoln project or economic feasibility prevent the use of a centralized system for DMA A, the dispersed BMP strategy proposed for DMA B may be applied to DMA A and vice versa, or both systems may work in conjunction together. The DMA breakdowns are provided below and the proposed Drainage Management Area Exhibit can be found in Appendix G.

PROPOSED CONDITION DRAINAGE MANAGEMENT AREAS (DMAs)			
DRAINAGE MANAGEMENT AREA	DMA ACREAGE	IMPERVIOUS PERCENTAGE	DEVELOPED RUNOFF COEFFICIENT
A1	14.6	96	0.87
A2	1.0	96	0.87
A3	4.6	96	0.87
A4	0.6	96	0.87
A5	5.0	74	0.69
A6	3.3	74	0.69
A7	1.0	96	0.87
A8	3.9	74	0.69
A9	4.5	10	0.18
A10	3.7	74	0.69
B1	10.3	74	0.69
B2	3.6	74	0.69
B3	7.8	74	0.69
B4	4.5	74	0.69
B5	8.5	74	0.69
Total	76.9	76.5%	0.71

Similar to existing conditions, the proposed condition will be tributary to the existing 36" storm drain located approximately 500 feet north of the south corner of the property. Both peak flow and treated low flow storm water runoff will discharge from the project site at this location. See Section 4.0 for proposed drainage facilities and Appendix B for the conceptual storm drain plan.

5.3. PROJECT PERFORMANCE CRITERIA

As mentioned, the proposed development project must mitigate the Stormwater Quality Design Volume (SWQDv) defined as the runoff from the 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map, which is 1.0 inch. BMPs selected shall rely on infiltration, bioretention, rainfall harvest and use, and/or biofiltration, as feasible.

Should the proposed Lincoln project employ biofiltration for treatment of stormwater runoff due to infeasibility of infiltration or harvest and re-use, the project will be required to biofiltrate 1.5 times the portion of the SWQDv that is not retained on-site or utilize modular flow-through treatment systems based on a rainfall intensity of 0.2 inches per hour, as specified by the Los Angeles County MS4 Permit. The table below provides the mitigation volumes and flow-rates for each Drainage Management Area under proposed conditions. Treatment BMPs selected for the project must be sized to provide the equivalent or greater treatment capacities than the listed volumes/flow-rates below. The County of Los Angeles Tc Calculator and LID Calculator (LID Runoff Rate Calculator and LID Runoff Volume Calculator) was used to generate the results shown below (http://dpw.lacounty.gov/wmd/dsp_LowImpactDevelopment.cfm).

As outlined in previous sub-sections, infiltration feasibility cannot be determined based on the currently available geotechnical information. Therefore, the proposed water quality solutions proposed herein will include alternatives for infiltration as well as biofiltration. These results are summarized in the table below. Both alternatives are shown in the Conceptual LID BMP Exhibits below. Should infiltration prove feasible in the future phases of the project's design development, the infiltration alternative will be selected for treatment of the project's stormwater runoff. Alternatively, should infiltration prove infeasible, the biofiltration alternative will be prescribed for the Lincoln development. Each scenario is described below.

Detailed calculations for the proposed treatment control BMPs, based on the Tc Calculator, are provided in Appendix F of this report. A summary table is provided below, which illustrates all treatment control BMPs selected for the project site meet the required minimum treatment flow rate for each of their respective drainage areas.

						INFILTRATION ALTERNATIVE	BIOFILTRATION ALTERNATIVE
DMA	DMA ACREAGE	% IMPERVIOUS*	SWQDv (INFILTRATION)	SWQDv x 1.5 (BIOFILTRATION)	SWQDf x 1.5 (BIOFILTRATION)	INFILTRATION BMP CAPACITY	VOLUME-BASED BIOFILTRATION BMP TREATMENT CAPACITY
A	42.2	79	2.53 acre-ft	3.80 acre-ft	12.01 cfs	Minimum Infiltrating Surface Area Required: A = 35,743 ft^2 A= SWQDv/ $((TP_{design}/12) + d_p)$ d_p = 3ft T =2 hrs P_{design} = 0.5 in/hr	Bioretention with Underdrain Surface Area Required: A = 27,025 ft^2 A = [(SWQDv)(l)] / $[(t)(P_{design}/12)(d+l)]$ P_{design} = 2.5 in/hr d = 1.5 ft l = 2 ft t = 16.8 hrs
B	34.7	74	1.97 acre-ft	2.97 acre-ft	9.88 cfs	Minimum Infiltrating Surface Area Required: A = 27,831 ft^2 A= SWQDv/ $((TP_{design}/12) + d_p)$ d_p = 3ft T =2 hrs P_{design} = 0.5 in/hr	Bioretention with Underdrain Surface Area Required: A = 21,122 ft^2 A = [(SWQDv)(l)] / $[(t)(P_{design}/12)(d+l)]$ P_{design} = 2.5 in/hr d = 1.5 ft l = 2 ft t = 16.8 hrs

*Impervious percentage estimates used in this table are greater than the 73.6% provided based on the project's proposed land uses. As a result, a more conservative value for SWQDv and SWQDf has been estimated.

Notes: SWQDv = Stormwater Quality Design Volume
SWQDf = Stormwater Quality Design Flow-Rate

INFILTRATION ALTERNATIVE

As shown in the table above, the project will require approximately 2.53 acre-feet and 1.97 acre-feet of infiltration, respectively, for DMAs A and B to treat the runoff from the 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map. Based on a storage depth of 3 feet, which is the maximum depth of water that can be infiltrated within the required 72 hour drain time for the minimum allowable percolation rate for infiltration of 0.5 inch per hour, the infiltration facility for DMA A will require a minimum footprint of 35,743 ft^2 to infiltrate 2.53 acre-feet of first-flush storm water runoff. Similarly, DMA B will require 27,831 ft^2 to infiltrate the requisite 1.97 acre-feet. These values are subject to change upon acquiring actual percolation rates at the project site during later phases of the project's design development.

Due to hydrologic/hydraulic constraints of the conceptual drainage, the infiltration facility for DMA A will likely be a subsurface infiltration gallery, as low flow runoff will be difficult to divert out of the main storm drain line at a feasible elevation to daylight at the surface. The proposed infiltration gallery will be located beneath the open space/park area at the center of the Lincoln property in DMA A8. It will be approximately 36,000 ft^2 in size with a total storage depth of 3 feet (when factoring void space, if any), providing more than 2.53 acre-feet or 110,207 ft^3 of treatment. Due to the ability to retain the entire MS4 design volume, all pollutants of concern are effectively mitigated by the facility, including metals, thereby addressing the Metals TMDL for the San Gabriel River.

The infiltration facility for DMA B will be located at three proposed locations within the open/space park areas of DMA B, should infiltration prove feasible. One facility is located in DMA B2 and two are located in DMA B5. Each infiltration facility will have approximately 10,000 ft^2 of footprint, providing a total of 30,000 ft^2. This exceeds the minimum 27,831 ft^2 required to infiltrate 1.97 acre-feet or 85,813 ft^3 of storm water runoff. The locations of infiltration BMPs are shown on the Conceptual LID BMP Exhibit Alternative #1 in Appendix G.

BIOFILTRATION ALTERNATIVE

Should infiltration prove infeasible based on subsequent geotechnical studies, biofiltration will be a feasible alternative in treating the runoff from the 85th percentile, 24-hour rain event for the project site, as determined from the Los Angeles County 85th percentile precipitation isohyetal map. A combination of bioretention with underdrains (volume-based) and modular flow-through bioretention systems (flow-based) will be utilized. Shown in the table above are the flow-based and volume-based treatment requirements for DMAs A and B. Due to the use of biofiltration, a 1.5x multiplier is applied to the storm water quality design volume and flow-rate for each respective DMA.

Volume-based bioretention with underdrain are vegetated shallow depressions (approximately 1.5 ft deep) that primarily remove pollutants by filtering storm water through plant uptake and an engineered soil mix. They also provide storm water runoff storage, infiltration, and evapotranspiration. The underdrain then routes treated flows to the storm drain system. According to the County of Los Angeles LID Manual, bioretention has a high pollutant removal effectiveness for sediment, nutrients, trash, metals, bacteria, oil and grease, and organics. As such, this BMP will address the current Metals TMDL for the San Gabriel River.

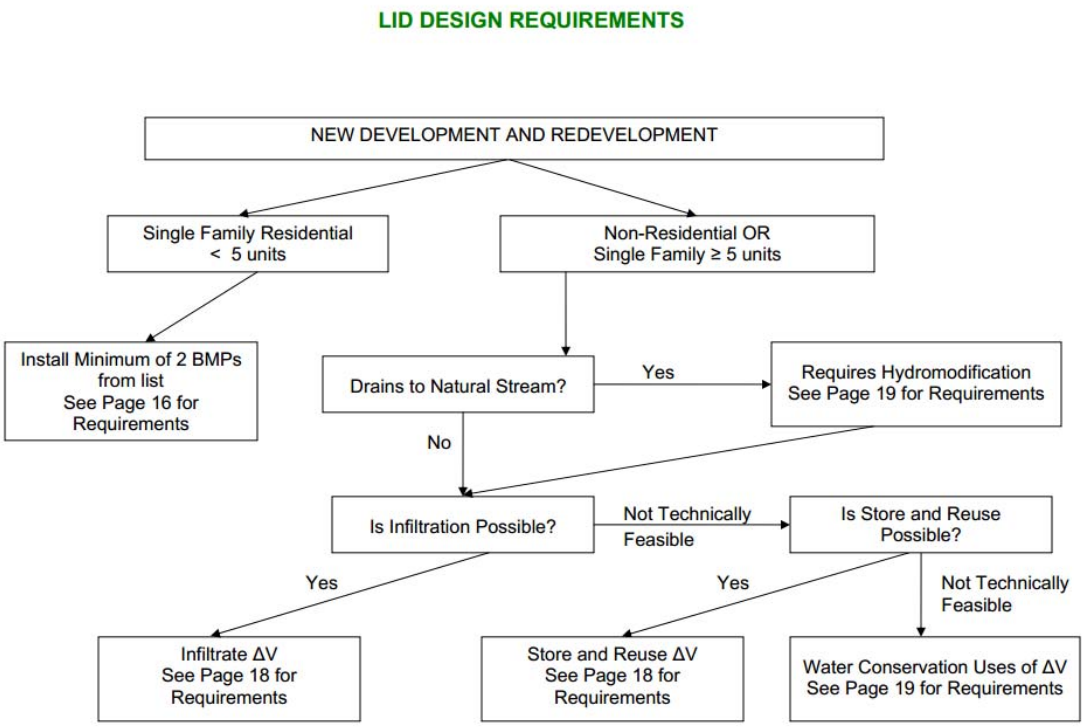
Flow-based modular biofiltration systems are structural media filtration devices that also utilize bioretention processes for storm water treatment. They typically feature a specially designed media filter mixture within a below-grade concrete vault. Drought tolerant plants with deep roots are planted within the media to provide additional pollutant removal, and function similar to traditional bioretention cells. The filter media is designed to capture and filter pollutants during the first-flush storm event, while biological processes degrade, metabolize, detoxify, and volatilize the pollutants during and between storms. They have been shown to have high pollutant removal efficiencies for TSS, nitrates, metals (copper, zinc), oils & grease, bacteria, and turbidity. Similar to the proposed bioretention with underdrain, the San Gabriel River Metals TMDL would be adequately addressed employing this LID BMP.

Due to hydrologic/hydraulic constraints of the conceptual drainage, DMA A will implement a flow-based modular bioretention system. The modular bioretention BMP will be sized to treat 12.01 cfs of first-flush storm water runoff. A volume-based bioretention BMP is infeasible, since surface ponding of storm water runoff will not be viable as low flow runoff will be difficult to divert out of the main storm drain line at a feasible elevation to daylight at the surface. Pipe invert elevations would be below the proposed surface elevation of the bioretention floor. The proposed modular bioretention BMP, which allows subsurface low-flow pipe inflows, will be located at the open space/park area at the center of the Lincoln property in DMA A8.

DMA B will utilize a combination of bioretention with underdrain and modular bioretention systems throughout the DMA. The modular bioretention systems will be located along the interior streets of the Lincoln property, whereas the volume-based bioretention with underdrain systems will be located within the several of the open space/park areas within DMA B2 and B5. See the Conceptual LID BMP Exhibits for locations. DMA B requires an equivalent minimum surface area of 21,122 ft^2 or 9.88 cfs of storm water runoff treatment through its use of a combination of both volume-based and flow-based bioretention BMPs. As currently planned, approximately 15,000 ft^2 of bioretention with underdrain will be provided, which accounts for 71% of stormwater runoff treatment for DMA B. The remaining 29% will be provided by modular bioretention BMPs totaling 2.86 cfs of storm water runoff treatment. The proportion of flow-based and volume-based BMP treatment provided is subject to change in future phases of the Lincoln project's design development, as proposed site conditions change. The locations of bioretention BMPs are shown on the Conceptual LID BMP Exhibit Alternative #2 in Appendix G.

6.0 LOW IMPACT DEVELOPMENT

The Lincoln project will implement Low Impact Development (LID) BMPs to the extent feasible in treating the site's storm water runoff mitigation requirements. The proposed project is considered a large scale development project, since it is a non-residential development as well as a residential project with 5 or more units. As recommended by the *County of Los Angeles Low Impact Development Standards Manual* (January 2009), the selection of LID BMPs proposed for the Lincoln project must follow the flow chart below.



Non-residential and large scale residential development projects are to prioritize selection of BMPs in the following order of preference: (1) infiltration, (2) storage and reuse, (3) biofiltration, and (4) other treatment BMPs at the discretion of the Director of Public Works that demonstrate compliance with LID requirements to the maximum extent practicable.

6.1 HYDROMODIFICATION

There are no hydromodification concerns associated with the project and the project site is considered exempt. The proposed project's runoff will discharge off-site via curb and gutter flows along Whittier Avenue to the MS4. The MS4 ultimately reaches Coyote Creek, which is a hardened, stabilized channel. Coyote Creek then confluences with the San Gabriel River, which is also a hardened channel from the point of confluence down to the Pacific Ocean. 25-year peak flows, however, will be detained as to match post-development flow rates with pre-development conditions.

6.2 INFILTRATION FEASIBILITY

LID hydrologic analysis is required to determine the infiltration requirements of the project site. In this case, it is consistent with existing MS4 stormwater design criteria, where it is determined by runoff from the 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map. For this analysis, the undeveloped LID runoff volume and the developed LID runoff volume is calculated and the difference in volume in excess of the undeveloped condition is required to be infiltrated wherever possible. The remaining developed runoff volume that is not infiltrated must be infiltrated or treated via volume-based or flow-based water quality design (i.e. infiltration, storage and reuse,

biofiltration, or conventional treatment control technologies as approved by the Director of Public Works).

In order to determine the existing condition LID runoff volume, the County of Los Angeles Tc Calculator and LID Calculator were utilized. The results are provided below, along with the proposed condition results that were determined in Section 5.0 of this report. Detailed calculations are provided in Appendix F.

EXISTING CONDITION LID VOLUME CALCULATIONS									
DRAINAGE AREA	DRAINAGE AREA ACREAGE	IMPERVIOUS PERCENTAGE	RUNOFF COEFFICIENT	SOIL TYPE	RAINFALL AMOUNT (in.)	FLOW PATH LENGTH (ft.)	FLOW PATH SLOPE	Tc (min.)	EXISING LID VOLUME (ft^3)
1A	7	0.20	0.26	017	1.0	1170	0.016	30	6,534
2B	5.6	0.75	0.70	017	1.0	1240	0.019	30	13,939
3C	3.3	0.75	0.70	017	1.0	881	0.017	30	8,276
5C	11.4	0.50	0.50	017	1.0	1059	0.019	30	20,473
7C	3.6	0.80	0.74	017	1.0	352	0.014	28	9,583
8A	10.6	0.25	0.30	017	1.0	1320	0.017	30	11,326
9D	14.9	0.40	0.42	017	1.0	1062	0.028	30	22,216
12A	4.3	0.20	0.26	017	1.0	500	0.019	30	3,920
13E	12.2	0.20	0.26	017	1.0	1156	0.025	30	11,326
F	3.6	0.80	0.74	017	1.0	792	0.008	30	9583
Total	*76.5*	--	--	--	--	--	--	--	*107,593*

PROPOSED CONDITION LID VOLUME CALCULATIONS									
DRAINAGE AREA	DRAINAGE AREA ACREAGE	IMPERVIOUS PERCENTAGE	RUNOFF COEFFICIENT	SOIL TYPE	RAINFALL AMOUNT (in.)	FLOW PATH LENGTH (ft.)	FLOW PATH SLOPE	Tc (min.)	PROPOSED LID VOLUME (ft^3)
A	42.2	79%	0.73	016	1.0	2,933	0.01	30	11,0207
B	34.7	74%	0.69	017	1.0	2,484	0.01	30	85,813
Total	*73.5*	--	--	--	--	--	--	--	*196,020*

As illustrated in the tables above, the excess volume (ΔV) between developed (196,020 ft^3) and undeveloped (107,593ft^3) runoff volumes is 88,427 ft^3. This excess volume is to be infiltrated at the project site, where feasible. However, it has not been determined in the project's Geotechnical Report that infiltration rates and soil conditions at the project site are suitable for infiltration BMPs. Therefore, infiltration of the LID excess volume is considered potentially feasible and feasibility will be determined in the later stages of the Lincoln project's design development. As a result, the project site has proposed two alternatives to address the LID treatment volume/flow-rate for the proposed development: (1) infiltration and (2) flow-through bioretention, see section 5.3.

As shown in Section 5.0, the volume provided by subsurface infiltration galleries will exceed 196,020 ft^3 of LID volume treatment by providing 36,000 ft^2 of infiltrating surface area at an effective storage depth of 3 feet. As a result, the project's LID requirements have been satisfied by the project's MS4 Stormwater Quality Design requirements described in Section 5.0 of this report. No additional LID BMPs are necessary, should infiltration BMPs be implemented.

6.3 STORAGE & REUSE FEASIBILITY

In accordance with the *County of Los Angeles Low Impact Development Standards Manual*, storage and reuse shall be considered should infiltration be determined infeasible. Since the primary use of captured runoff is for subsurface drip irrigation purposes, the proposed on-site irrigation demand was calculated for wet season months (October through April) to evaluate reuse feasibility. Demand requirements were calculated based on the proposed landscaping area, 18.1 acres (76.5% site imperviousness), and compared with the minimum LID design capture runoff volume of 196,020 ft^3 for the project site.

At a minimum, storage and reuse BMPs must be designed and maintained to ensure adequate capacity is available to capture the storm water quality design volume (SWQDv) within 3 days

(72 hours) of a likely storm event. The evaluation performed herein is derived from City of Los Angeles feasibility screening guidelines for capture and use, which initially screens to see if the 7 month wet season irrigation demand ($ETWU_{7\text{-month}}$) is more than the LID design volume or SWQDv. Once this threshold is met, a final determination is made by assessing the estimated daily average water usage during the wet season, to ensure that there is enough irrigation demand from the project site during the rainy season to effectively utilize and draw down the SWQDv during a 72-hour period.

Based on the initial screening method, storage and reuse of stormwater runoff is considered potentially feasible since the SWQDv $\leq$ $ETWU_{7\text{-month}}$. See calculations below.

Given for Proposed Project:

Impervious Area	58.8 acres
Pervious Area	18.1 acres
Total Tributary Area	76.9 acres
Total Site Irrigated Area	787,478 ft^2
ETo Wet Season (Oct-April)	21.7 (Los Angeles area)[1] = ET_7
Planting Factor (PF)	0.5 = Medium Planting Type, moderate water use.

Step 1: Calculate the Design Volume in Gallons (for 72-hour holding time)

SWQDv = 196,020 ft^3 x 7.48 gal/ft^3 = 1,466,230 gallons

Step 2: Determine Planter Factor

Planter Factor (PF) = Planting Factor x Irrigated Area
= 0.5 x 787,478 ft^2
= 393,739 ft^2

Step 3: Determine the 7-Month (Oct 1 – April 30) Estimated Total Water Use (ETWU)

Wet Season Estimated Total Water Use ($ETWU_{7\text{-month}}$) = ET_7 x 0.62 x PF
= 21.7 x 0.62 x 393,739 ft^2
= 5,297,362 gallons

Step 4: Determine if Captured Volume is Equal or Less Than Irrigation Demand (ETWU)

Is SWQDv $\leq$ $ETWU_{7\text{-month}}$?

Yes – Demand ($ETWU_{7\text{-month}}$) is greater than SWQDv. Storage and reuse is potentially feasible.

[1] Reference Evapotranspiration (ETo) Table from City of Los Angeles Irrigation Guidelines (Local Implementation of AB 1881).

STORAGE & REUSE FEASIBILITY SCREENING SUMMARY						
BMP	**Project Acreage**	**Irrigated Area (ft^2)**	**Design Volume**	**Plant Factor (PF)**	**7-Month ETWU**	**Meets Initial Screening Criteria?**
Irrigation Reuse	76.9 ac	787,478 ft^2	1,466,230 gallons	393,739ft^2	5,297,362 gallons	Yes

Despite the feasibility screening resulted in stormwater storage and reuse being potentially feasible, it is necessary to determine that the Stormwater Quality Design Volume can be adequately drawn down within 72 hours in order for it to be implemented on the project. This is determined by estimating the daily average water demand during the wet season. Since the $ETWU_{7\text{-month}}$ is approximately 5,297,362 gallons, the average daily water demand is roughly 24,754 gallons per day (214 days). Over a 72 hour period, it appears that the daily average water usage during the wet season is insufficient to utilize and draw down the SWQDv, since the total water demand is 49,508 gallons, assuming that the first 24 hours after a rain event there is no water demand. Only 3.4% of the SWQDv (49,508 gallons of 1,466,230 gallons) would be used for irrigation of the landscaped area within the project site over a 72-hour period, with approximately 1,416,722 gallons remaining in storage and unutilized. A significant amount of runoff treatment would be bypassed should a subsequent storm event follow shortly after the first. Therefore, stormwater runoff storage and reuse is considered not feasible.

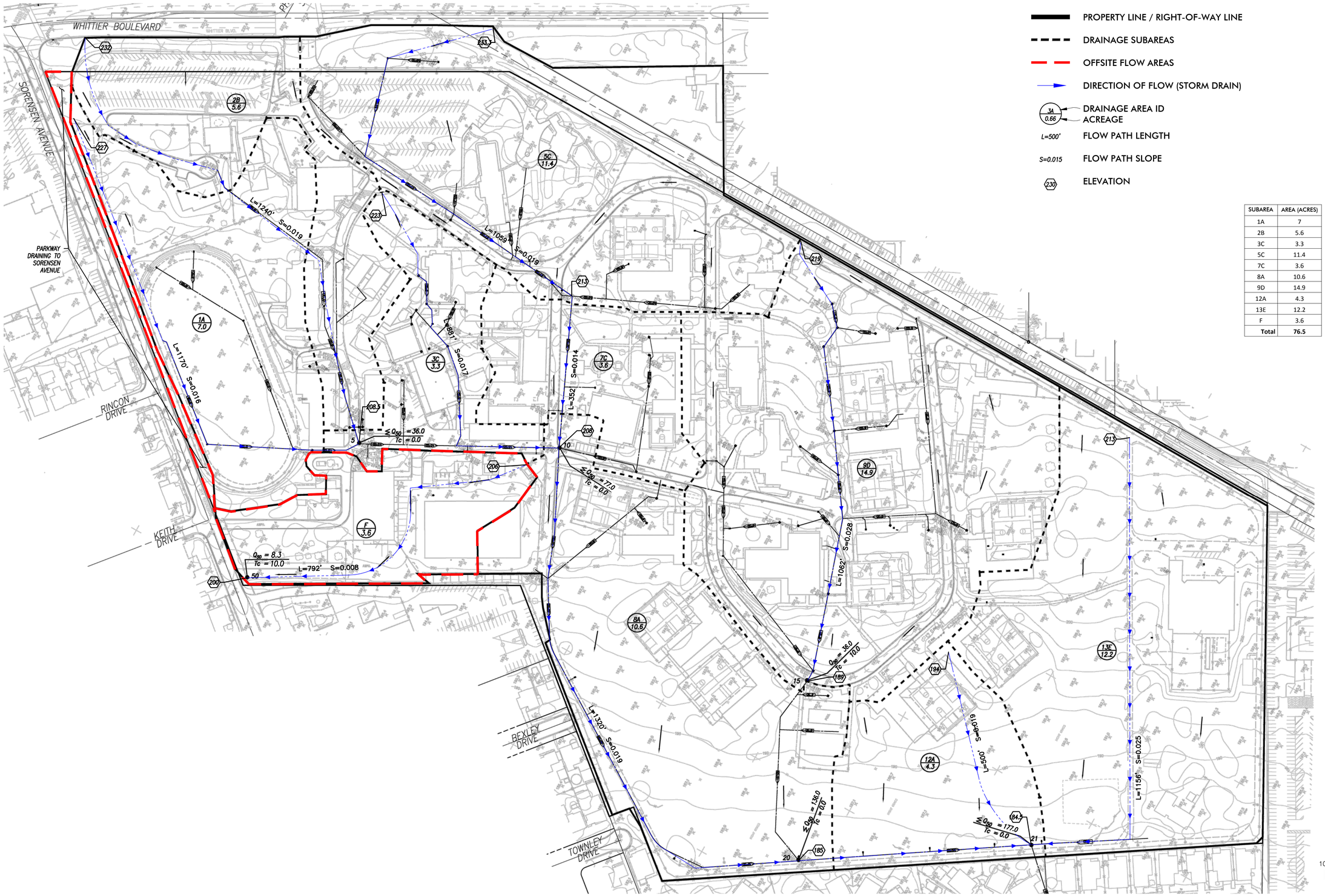
6.4 BIOFILTRATION

Should infiltration LID BMPs prove to be infeasible during the later stages of the Lincoln project's design development, biofiltration through the use of flow-through bioretention is considered a feasible alternative method of stormwater runoff treatment for the project. As a result of utilizing bioretention, an even greater amount of LID treatment would be provided due to the MS4 Stormwater Quality Design requirement to treat 1.5 times the SWQDv. Therefore, the project's LID requirements have been satisfied by the project's MS4 Stormwater Quality Design requirements found in Section 5.0 of this report. An equivalent of over 6.77 acre-feet (294,901 ft^3) or 21.89 cfs of storm water runoff treatment will be provided. This exceeds the 88,427 ft^3 of LID volume difference of the developed condition in excess of the undeveloped condition to be treated. No additional LID BMPs are necessary.

As previously described, the flow-through LID BMPs will be located throughout the Lincoln property, with modular bioretention systems along the interior streets of the site and bioretention with underdrains located within open space/park areas of the property. Potential locations to each bioretention BMP is provided in the Conceptual LID BMP exhibits. Each bioretention system is sized according to their volume-based or flow-based treatment design requirement, which is described in Section 5.0.

APPENDICES

APPENDIX A



LEGEND

- PROPERTY LINE / RIGHT-OF-WAY LINE
- DRAINAGE SUBAREAS
- OFFSITE FLOW AREAS
- DIRECTION OF FLOW (STORM DRAIN)
- 3A / 0.66 — DRAINAGE AREA ID / ACREAGE
- L=500' — FLOW PATH LENGTH
- S=0.015 — FLOW PATH SLOPE
- 230 — ELEVATION

SUBAREA	AREA (ACRES)
1A	7
2B	5.6
3C	3.3
5C	11.4
7C	3.6
8A	10.6
9D	14.9
12A	4.3
13E	12.2
F	3.6
Total	**76.5**

SUBAREA	AREA (ACRES)
Parkway Draining to Sorrensen Ave	0.4

TOTAL AREA	76.9

100' 0' 50' 100' 200'

SCALE: 1" = 100'

FUSCOE ENGINEERING
16795 Von Karman, Suite 100
Irvine, California 92606
tel 949.474.1960 * fax 949.474.5315
www.fuscoe.com

N

Scale: 1" = 100'

Exhibit Date: 3/21/2013

EXISTING CONDITION HYDROLOGY MAP BROOKFIELD - LINCOLN WHITTIER, CA

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LEGEND

- PROPERTY LINE / RIGHT-OF-WAY LINE
- DIRECTION OF FLOW (STORM DRAIN)
- A3 / 0.66 — DRAINAGE AREA ID / ACREAGE
- L=500' — FLOW PATH LENGTH
- S=0.015 — FLOW PATH SLOPE
- 230 — ELEVATION

Subarea	Area (acres)
A1	14.6
A2	1.0
A3	4.6
A4	0.6
A5	5.0
A6	3.3
A7	1.0
A8	3.9
A9	4.5
A10	3.7
B1	10.3
B2	3.6
B3	7.8
B4	4.5
B5	8.5
Total Acerage	76.9

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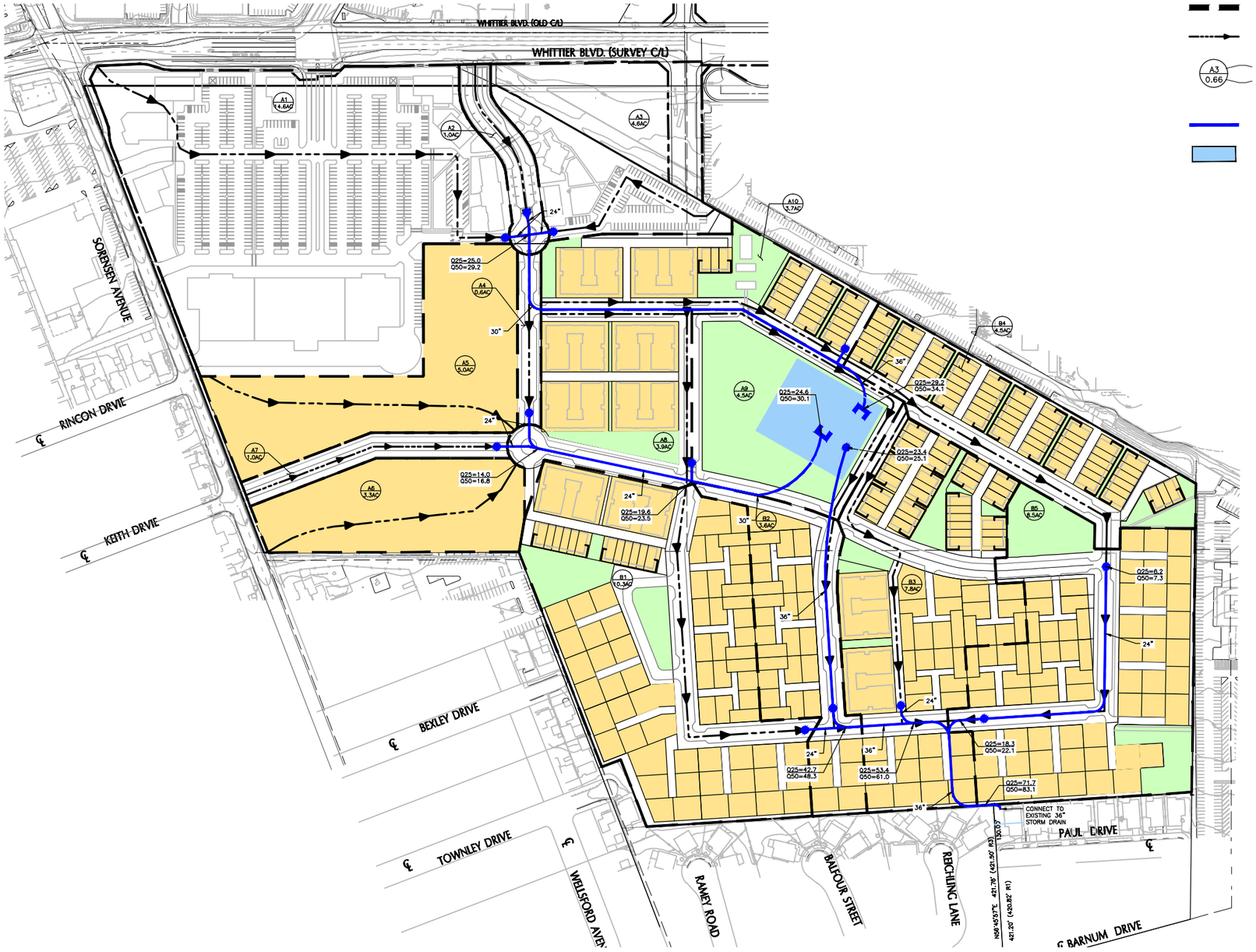
Scale: 1" = 100'

Exhibit Date: 3/21/2013

PROPOSED CONDITION HYDROLOGY MAP BROOKFIELD - LINCOLN WHITTIER, CA

P:\PROJECTS\30850\30850\ENG\EXHIBITS\HYDROLOGY\30850-XH-PROPOSED HYDROLOGY.DWG (02-26-14 1:56:09PM) Plotted by: Gordon Chan

APPENDIX B



LEGEND

- PROPERTY LINE / RIGHT-OF-WAY LINE
- DIRECTION OF FLOW (STORM DRAIN)
- A3 / 0.66 — DRAINAGE AREA ID, ACREAGE, DIRECTION OF FLOW (STORM DRAIN)
- STORMDRAIN
- DETENTION BASIN

AREA TO DETENTION

Subarea	Area (acres)
A1	14.6
A2	1.0
A3	4.6
A4	0.6
A5	5.0
A6	3.3
A7	1.0
A8	3.9
A9	4.5
A10	3.7

AREA TO 36" PIPE

Subarea	Area (acres)
B1	10.3
B2	3.6
B3	7.8
B4	4.5
B5	8.5

300' 0' 150' 300' 600'

SCALE: 1" = 300'

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N

Scale: 1" = 300'

Exhibit Date: 3/21/2013

CONCEPTUAL STORM DRAIN EXHIBIT BROOKFIELD - LINCOLN WHITTIER, CA

APPENDIX C

Hydrology Summary
BrookField Residential, Lincoln

Existing Areas	Acerage	Comment
1A	7.0	Direct To Ex 36" RCP
2B	5.6	Direct To Ex 36" RCP
3C	3.3	Direct To Ex 36" RCP
5C	11.4	Direct To Ex 36" RCP
7C	3.6	Direct To Ex 36" RCP
8A	10.6	Direct To Ex 36" RCP
9D	14.9	Direct To Ex 36" RCP
12A	4.3	Direct To Ex 36" RCP
13E	12.2	Direct To Ex 36" RCP
F	3.6	To Off Site
Parkway	0.4	To Off Site
Total Area	**76.9**	

Proposed Areas	Acerage	Comment
A1	14.6	To Park Detention
A2	1.0	To Park Detention
A3	4.6	To Park Detention
A4	0.6	To Park Detention
A5	5.0	To Park Detention
A6	3.3	To Park Detention
A7	1.0	To Park Detention
A8	3.9	To Park Detention
A9	4.5	To Park Detention
A10	3.7	To Park Detention
B1	10.3	Direct To Ex 36" RCP
B2	3.6	Direct To Ex 36" RCP
B3	7.8	Direct To Ex 36" RCP
B4	4.5	Direct To Ex 36" RCP
B5	8.5	Direct To Ex 36" RCP
Total Area	**76.9**	

Existing 25 Years TC Results

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	1A	7	0.2	25 Years	17	1170	0.016	5.268	12	2.08	0.85	0.86	12.52	1.13
Nelle	2B	5.6	0.75	25 Years	17	1240	0.019	5.268	12	2.08	0.85	0.89	10.37	1.79
Nelle	3C	3.3	0.75	25 Years	17	881	0.017	5.268	10	2.27	0.86	0.89	6.67	1.05
Nelle	5C	11.4	0.5	25 Years	17	1059	0.019	5.268	11	2.17	0.85	0.88	21.77	2.82
Nelle	7C	3.6	0.8	25 Years	17	352	0.014	5.268	6	2.88	0.89	0.9	9.33	1.2
Nelle	8A	10.6	0.25	25 Years	17	1320	0.017	5.268	13	2.01	0.84	0.86	18.32	1.87
Nelle	9D	14.9	0.4	25 Years	17	1062	0.028	5.268	10	2.27	0.86	0.88	29.76	3.25
Nelle	12A	4.3	0.2	25 Years	17	500	0.019	5.268	7	2.68	0.88	0.88	10.14	0.7
Nelle	13E	12.2	0.2	25 Years	17	1156	0.025	5.268	11	2.17	0.85	0.86	22.77	1.95
*Nelle	F	3.6	0.8	25 Years	17	792	0.008	5.268	11	2.17	0.85	0.89	6.95	1.2
	Total	**76.5**										**Total**	**141.65**	**15.76**

Parkway draining to Sorensen Ave	0.4
Total Acerage	**76.9**

* Subarea F flows towards Sorensen Avenue and is not included in the total flow rate and volume.

Existing 50 Years TC Results

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	1A	7	0.2	50 Years	17	1170	0.016	5.95	11	2.45	0.87	0.88	15.09	1.32
Nelle	2B	5.6	0.75	50 Years	17	1240	0.019	5.95	11	2.45	0.87	0.89	12.21	2.03
Nelle	3C	3.3	0.75	50 Years	17	881	0.017	5.95	9	2.69	0.88	0.9	7.99	1.2
Nelle	5C	11.4	0.5	50 Years	17	1059	0.019	5.95	10	2.56	0.88	0.89	25.97	3.24
Nelle	7C	3.6	0.8	50 Years	17	352	0.014	5.95	5	3.55	0.9	0.9	11.5	1.37
Nelle	8A	10.6	0.25	50 Years	17	1320	0.017	5.95	12	2.35	0.86	0.87	21.67	2.19
Nelle	9D	14.9	0.4	50 Years	17	1062	0.028	5.95	10	2.56	0.88	0.89	33.95	3.76
Nelle	12A	4.3	0.2	50 Years	17	500	0.019	5.95	6	3.26	0.9	0.9	12.62	0.81
Nelle	13E	12.2	0.2	50 Years	17	1156	0.025	5.95	10	2.56	0.88	0.88	27.48	2.31
*Nelle	F	3.6	0.8	50 Years	17	792	0.008	5.95	10	2.56	0.88	0.9	8.29	1.36
	Total	**76.5**										**Total**	**168.48**	**18.23**

Parkway draining to Sorensen Ave	0.4
Total Acerage	**76.9**

* Subarea F flows towards Sorensen Avenue and is not included in the total flow rate and volume.

Proposed 25 Years TC Results

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	A1	14.6	0.96	25 Years	16	1365	0.0066	5.268	15	1.88	0.7	0.9	24.43	5.54
Nelle	A2	1.0	0.96	25 Years	16	521	0.0220	5.268	7	2.68	0.8	0.9	2.41	0.38
Nelle	A3	4.6	0.96	25 Years	16	527	0.0020	5.268	10	2.27	0.8	0.9	9.40	1.75
Nelle	A4	0.6	0.96	25 Years	16	431	0.0500	5.268	5	3.14	0.9	0.9	1.70	0.23
Nelle	A5	5.0	0.74	25 Years	16	809	0.0140	5.268	10	2.27	0.8	0.9	9.87	1.55
Nelle	A6	3.3	0.74	25 Years	16	702	0.0140	5.268	9	2.38	0.8	0.9	6.83	1.03
Nelle	A7	1.0	0.96	25 Years	16	686	0.0029	5.268	12	2.08	0.8	0.9	1.85	0.38
Nelle	A8	3.9	0.74	25 Years	16	800	0.0200	5.268	9	2.38	0.8	0.9	8.08	1.21
Nelle	A9	4.5	0.10	25 Years	16	900	0.0128	5.268	12	2.08	0.8	0.8	7.30	0.51
Nelle	A10	3.7	0.74	25 Years	16	810	0.0012	5.268	15	1.88	0.7	0.9	5.98	1.15
Nelle	B1	10.3	0.74	25 Years	17	960	0.0135	5.268	11	2.17	0.9	0.9	19.89	3.25
Nelle	B2	3.6	0.74	25 Years	17	605	0.0300	5.268	7	2.68	0.9	0.9	8.59	1.14
Nelle	B3	7.8	0.74	25 Years	17	1031	0.0286	5.268	10	2.27	0.9	0.9	15.76	2.46
Nelle	B4	4.5	0.74	25 Years	17	855	0.0200	5.268	10	2.27	0.9	0.9	9.09	1.42
Nelle	B5	8.5	0.74	25 Years	17	810	0.0200	5.268	9	2.38	0.9	0.9	18.00	2.69
	Total	**76.9**										**Total**	**149.18**	**24.69**

Proposed 50 Years TC Results

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	A1	14.6	0.96	50 Years	16	1365	0.0066	5.95	14	2.19	0.78	0.90	28.78	6.27
Nelle	A2	1.0	0.96	50 Years	16	521	0.0220	5.95	6	3.26	0.86	0.90	2.93	0.43
Nelle	A3	4.6	0.96	50 Years	16	527	0.0020	5.95	10	2.56	0.82	0.90	10.60	1.97
Nelle	A4	0.6	0.96	50 Years	16	431	0.0500	5.95	5	3.55	0.88	0.90	1.92	0.26
Nelle	A5	5.0	0.74	50 Years	16	809	0.0140	5.95	9	2.69	0.83	0.88	11.84	1.76
Nelle	A6	3.3	0.74	50 Years	16	702	0.0140	5.95	8	2.85	0.84	0.88	8.28	1.17
Nelle	A7	1.0	0.96	50 Years	16	686	0.0029	5.95	11	2.45	0.81	0.90	2.21	0.43
Nelle	A8	3.9	0.74	50 Years	16	800	0.0200	5.95	8	2.85	0.84	0.88	9.78	1.38
Nelle	A9	4.5	0.10	50 Years	16	900	0.0128	5.95	10	2.56	0.82	0.83	9.56	0.59
Nelle	A10	3.7	0.74	50 Years	16	810	0.0012	5.95	14	2.19	0.78	0.87	7.05	1.30
Nelle	B1	10.3	0.74	50 Years	17	960	0.0135	5.95	10	2.56	0.88	0.89	23.47	3.70
Nelle	B2	3.6	0.74	50 Years	17	605	0.0300	5.95	6	3.26	0.90	0.90	10.56	1.29
Nelle	B3	7.8	0.74	50 Years	17	1031	0.0286	5.95	9	2.69	0.88	0.89	18.67	2.81
Nelle	B4	4.5	0.74	50 Years	17	855	0.0200	5.95	9	2.69	0.88	0.89	10.77	1.62
Nelle	B5	8.5	0.74	50 Years	17	810	0.0200	5.95	8	2.85	0.89	0.90	21.80	3.08
	Total	**76.9**										**Total**	**178.22**	**28.06**

APPENDIX D

Hydrology Map

A GIS viewer application to view the data for the hydrology manual.

LAYERS

- [ ] 50yr Two Tenths (Rainfall)
- [ ] DPA Zones
- [x] Soils 2004
- [ ] TG Page
- [ ] Final 85th Percentile, 24-hr Rainfall

SEARCH

Zoom to TG Page:

Enter Address, Cross Street, or Parcel No.:

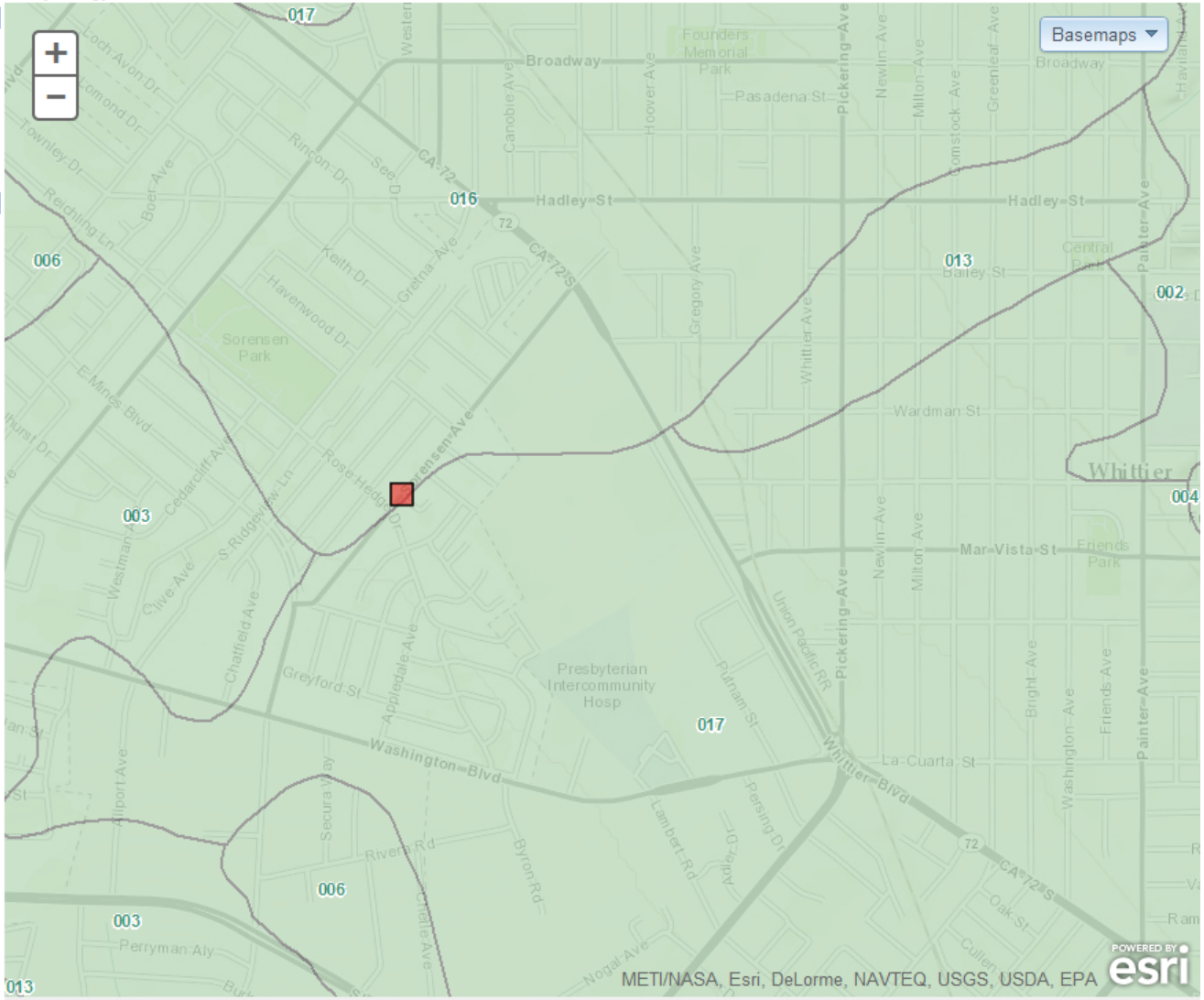
(ex: 900 S. Fremont Ave., Fremont@Valley, 5342005904)

whittier and sorensen | Search

Address Search Results:

Sorensen Park, 11419 Rose Hedge Drive, Whittier, CA 90606, USA

Sorensen Avenue, Whittier, CA 90606, USA



Map Tips

APPENDIX E

To Detention

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	A1	14.6	0.96	25 Years	16	1365	0.0066	5.268	15	1.88	0.74	0.89	24.43	5.54
Nelle	A2	1.0	0.96	25 Years	16	521	0.0220	5.268	7	2.68	0.82	0.9	2.41	0.38
Nelle	A3	4.6	0.96	25 Years	16	527	0.0020	5.268	10	2.27	0.79	0.9	9.40	1.75
Nelle	A4	0.6	0.96	25 Years	16	431	0.0500	5.268	5	3.14	0.86	0.9	1.70	0.23
Nelle	A5	5.0	0.74	25 Years	16	809	0.0140	5.268	10	2.27	0.79	0.87	9.87	1.55
Nelle	A6	3.3	0.74	25 Years	16	702	0.0140	5.268	9	2.38	0.8	0.87	6.83	1.03
Nelle	A7	1.0	0.96	25 Years	16	686	0.0029	5.268	12	2.08	0.77	0.89	1.85	0.38
Nelle	A8	3.9	0.74	25 Years	16	800	0.0200	5.268	9	2.38	0.8	0.87	8.08	1.21
Nelle	A9	4.5	0.10	25 Years	16	900	0.0128	5.268	12	2.08	0.77	0.78	7.30	0.51
Nelle	A10	3.7	0.74	25 Years	16	810	0.0012	5.268	15	1.88	0.74	0.86	5.98	1.15
	Subtotal	*42.2*									*Subtotal*		*77.85*	*13.73*

To 36" PVC

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	B1	10.3	0.74	25 Years	17	960	0.0135	5.268	11	2.17	0.85	0.89	19.89	3.25
Nelle	B2	3.6	0.74	25 Years	17	605	0.0300	5.268	7	2.68	0.88	0.89	8.59	1.14
Nelle	B3	7.8	0.74	25 Years	17	1031	0.0286	5.268	10	2.27	0.86	0.89	15.76	2.46
Nelle	B4	4.5	0.74	25 Years	17	855	0.0200	5.268	10	2.27	0.86	0.89	9.09	1.42
Nelle	B5	8.5	0.74	25 Years	17	810	0.0200	5.268	9	2.38	0.87	0.89	18.00	2.69
	Subtotal	*34.7*									*Subtotal*		*71.33*	*10.96*
	Total	**76.9**									**Total**		**149.18**	**24.69**

To Detention

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	A1	14.6	0.96	50 Years	16	1365	0.0066	5.95	14	2.19	0.78	0.9	28.78	6.27
Nelle	A2	1	0.96	50 Years	16	521	0.022	5.95	6	3.26	0.86	0.9	2.93	0.43
Nelle	A3	4.6	0.96	50 Years	16	527	0.002	5.95	10	2.56	0.82	0.9	10.60	1.97
Nelle	A4	0.6	0.96	50 Years	16	431	0.05	5.95	5	3.55	0.88	0.9	1.92	0.26
Nelle	A5	5	0.74	50 Years	16	809	0.014	5.95	9	2.69	0.83	0.88	11.84	1.76
Nelle	A6	3.3	0.74	50 Years	16	702	0.014	5.95	8	2.85	0.84	0.88	8.28	1.17
Nelle	A7	1	0.96	50 Years	16	686	0.0029	5.95	11	2.45	0.81	0.9	2.21	0.43
Nelle	A8	3.9	0.74	50 Years	16	800	0.02	5.95	8	2.85	0.84	0.88	9.78	1.38
Nelle	A9	4.5	0.1	50 Years	16	900	0.0128	5.95	10	2.56	0.82	0.83	9.56	0.59
Nelle	A10	3.7	0.74	50 Years	16	810	0.0012	5.95	14	2.19	0.78	0.87	7.05	1.30
	Subtotal	*42.2*									*Subtotal*		*92.95*	*15.56*

To 36" PVC

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	B1	10.3	0.74	50 Years	17	960	0.0135	5.95	10	2.56	0.88	0.89	23.47	3.70
Nelle	B2	3.6	0.74	50 Years	17	605	0.03	5.95	6	3.26	0.9	0.9	10.56	1.29
Nelle	B3	7.8	0.74	50 Years	17	1031	0.0286	5.95	9	2.69	0.88	0.89	18.67	2.81
Nelle	B4	4.5	0.74	50 Years	17	855	0.02	5.95	9	2.69	0.88	0.89	10.77	1.62
Nelle	B5	8.5	0.74	50 Years	17	810	0.02	5.95	8	2.85	0.89	0.9	21.80	3.08
	Subtotal	*34.7*									*Subtotal*		*85.27*	*12.50*
	Total	**76.9**									**Total**		**178.22**	**28.06**

Nelles Park Site Detention

Area Tributary To Park Detention:	42.2 ac
Area Downstream Of Park Site:	34.7 ac
WQ Volume (1.0″ Rainfall):	2.53 ac-ft
WQ Depth:	2.5′
Basin Area Needed:	44,083 sf
Area of 210′ x 250′ Basin:	52,500 sf

Results

No downstream detention needed downstream of park site detention.

Q Released to exist 36″ RCP:	Q25 = 71.7 cfs Q50 = 83.1 cfs

Tc Calculator

Subarea Parameters Manual Input

Subarea Number	Fire Factor	
1	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
200	.1	9
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
6	4538	.077

Subarea Parameters Selected

Subarea Number	Fire Factor	
To Basin	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
42.2	0.79	16
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
1	2933	0.01

Input File

☑ Check Here If Subarea Parameters Are Defined In An Input File

Import "tcdata.xls" File

◉ Calculate Single Tc From Subarea Parameters Provided In Input File

○ Calculate Tc's For Multiple Subareas And Create Tc Results File

Calculation Results

Subarea Number	Intensity	Undeveloped Runoff Coefficient (Cu)	Developed Runoff Coefficient (Cd)
To Basin	0.26	0.1	0.73

☑ Calculate Runoff Volume

Calculate T

Cancel

Tc Equation

Tc=(10)^-0.507*(Cd*I)^-0.519*(L)^0.483*(S)^-0.135

Tc Value (min.)	Peak Flow Rate (cfs)	Burned Peak Flow Rate (cfs)	24-Hour Runoff Volume (acre-ft)
30	8.01	n/a	2.53

PROPOSED LID TO DETENTION BASIN

Tc Calculator

Subarea Parameters Manual Input

Subarea Number	Fire Factor	
1	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
200	.1	9
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
6	4538	.077

Subarea Parameters Selected

Subarea Number	Fire Factor	
To Basin	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
42.2	0.79	16
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
5.268	2933	0.01

Input File

☑ Check Here If Subarea Parameters Are Defined In An Input File

Import "tcdata.xls" File

◉ Calculate Single Tc From Subarea Parameters Provided In Input File

○ Calculate Tc's For Multiple Subareas And Create Tc Results File

Calculation Results

Subarea Number	Intensity	Undeveloped Runoff Coefficient (Cu)	Developed Runoff Coefficient (Cd)
To Basin	1.5	0.68	0.85

☑ Calculate Runoff Volume

Calculate T

Cancel

Tc Equation

Tc=(10)^-0.507*(Cd*I)^-0.519*(L)^0.483*(S)^-0.135

Tc Value (min.)	Peak Flow Rate (cfs)	Burned Peak Flow Rate (cfs)	24-Hour Runoff Volume (acre-ft)
24	53.81	n/a	13.7

PROPOSED 25 YEAR TO DETENTION BASIN

Tc Calculator

Subarea Parameters Manual Input

Subarea Number	Fire Factor	
1	0	
Area (Acres)	Proportion Impervious	Soil Type
200	.1	9
Rainfall Isohyet (in.)	Flow Path Length (ft.)	Flow Path Slope
6	4538	.077

Subarea Parameters Selected

Subarea Number	Fire Factor	
To 36" Pipe	0	
Area (Acres)	Proportion Impervious	Soil Type
34.7	0.74	17
Rainfall Isohyet (in.)	Flow Path Length (ft.)	Flow Path Slope
5.268	2484	0.01

Input File

☑ Check Here If Subarea Parameters Are Defined In An Input File

Import "tcdata.xls" File

◉ Calculate Single Tc From Subarea Parameters Provided In Input File

○ Calculate Tc's For Multiple Subareas And Create Tc Results File

Calculation Results

Subarea Number	Intensity	Undeveloped Runoff Coefficient (Cu)	Developed Runoff Coefficient (Cd)
To 36" Pipe	1.6	0.8	0.87

☑ Calculate Runoff Volume

Calculate T

Cancel

Tc Equation

Tc=(10)^-0.507*(Cd*I)^-0.519*(L)^0.483*(S)^-0.135

Tc Value (min.)	Peak Flow Rate (cfs)	Burned Peak Flow Rate (cfs)	24-Hour Runoff Volume (acre-ft)
21	48.3	n/a	10.93

PROPOSED 25 YEAR TO EXISTING 36" RCP

Tc Calculator

Subarea Parameters Manual Input

Subarea Number	Fire Factor	
1	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
200	.1	9
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
6	4538	.077

Subarea Parameters Selected

Subarea Number	Fire Factor	
To Basin	0	
Area (Acres)	**Proportion Impervious**	**Soil Type**
42.2	0.79	16
Rainfall Isohyet (in.)	**Flow Path Length (ft.)**	**Flow Path Slope**
5.95	2933	0.01

Input File

☑ Check Here If Subarea Parameters Are Defined In An Input File

Import "tcdata.xls" File

◉ Calculate Single Tc From Subarea Parameters Provided In Input File

○ Calculate Tc's For Multiple Subareas And Create Tc Results File

Calculation Results

Subarea Number	Intensity	Undeveloped Runoff Coefficient (Cu)	Developed Runoff Coefficient (Cd)
To Basin	1.77	0.72	0.86

☑ Calculate Runoff Volume

Calculate T

Cancel

Tc Equation

Tc=(10)^-0.507*(Cd*I)^-0.519*(L)^0.483*(S)^-0.135

Tc Value (min.)	Peak Flow Rate (cfs)	Burned Peak Flow Rate (cfs)	24-Hour Runoff Volume (acre-ft)
22	64.24	n/a	15.56

PROPOSED 50 YEAR TO DETENTION BASIN

Tc Calculator

Subarea Parameters Manual Input

Subarea Number	Fire Factor	
1	0	
Area (Acres)	Proportion Impervious	Soil Type
200	.1	9
Rainfall Isohyet (in.)	Flow Path Length (ft.)	Flow Path Slope
6	4538	.077

Subarea Parameters Selected

Subarea Number	Fire Factor	
To 36" Pipe	0	
Area (Acres)	Proportion Impervious	Soil Type
34.7	0.74	17
Rainfall Isohyet (in.)	Flow Path Length (ft.)	Flow Path Slope
5.95	2484	0.01

Input File

☑ Check Here If Subarea Parameters Are Defined In An Input File

Import "tcdata.xls" File

◉ Calculate Single Tc From Subarea Parameters Provided In Input File

○ Calculate Tc's For Multiple Subareas And Create Tc Results File

Calculation Results

Subarea Number	Intensity	Undeveloped Runoff Coefficient (Cu)	Developed Runoff Coefficient (Cd)
To 36" Pipe	1.9	0.83	0.88

☑ Calculate Runoff Volume

Calculate T

Cancel

Tc Equation

Tc=(10)^-0.507*(Cd*I)^-0.519*(L)^0.483*(S)^-0.135

Tc Value (min.)	Peak Flow Rate (cfs)	Burned Peak Flow Rate (cfs)	24-Hour Runoff Volume (acre-ft)
19	58.02	n/a	12.47

PROPOSED 50 YEAR TO EXISTING 36" RCP

Hydraulic Analysis Report

Project Data

Project Title: 30850 - Brookfield Lincoln

Designer:

Project Date: Thursday, February 20, 2014

Project Units: U.S. Customary Units

Notes:

Detention Basin Analysis: 25 Year Detention Basin Analysis

Notes:

Storage Input Parameters

Storage Capacity: Known geometry

Length: 250.0000 (ft)

Width: 210.0000 (ft)

Depth: 10.0000 (ft)

Side slope: 0.0000 (ft/ft)

Base elevation: 0.0000 (ft)

Discharge Input Parameters

Outlet: Outlet 1"""""""

Outlet Type: Circular

Diameter: 1.5000 (ft)

Height above base: 0.0000 (ft)

Manning's n: 0.0130

Slope: 0.0100 (ft/ft)

Orifice Coefficient: 0.6000

Base Elevation: 0.0000 (ft)

Storage & Discharge Input Parameters

Elevation - Storage - Discharge

Elevation (ft)	Storage (acre-ft)	Discharge (cfs)
0.00	0.00	0.00
1.67	2.01	8.15
3.33	4.02	13.68
5.00	6.03	17.54
6.67	8.03	20.70
8.33	10.04	23.43
10.00	12.05	25.88

Detention Basin Input Parameters

Inflow Hydrograph

Peak Inflow Discharge: 53.630 (cfs), Time to Peak: 1159.00 (min), Total Inflow Volume: 599007.00 (ft^3)

Time (min)	Discharge (cfs)
0.00	0.00
24.00	3.60
29.00	3.61
34.00	3.62
39.00	3.62
44.00	3.63
49.00	3.64
54.00	3.65
59.00	3.65
64.00	3.66
69.00	3.67
74.00	3.68
79.00	3.69
84.00	3.69
89.00	3.70
94.00	3.71
99.00	3.72
104.00	3.73
109.00	3.74
114.00	3.74
119.00	3.75
124.00	3.76
129.00	3.77
134.00	3.78
139.00	3.79
144.00	3.79
149.00	3.80
154.00	3.81
159.00	3.82
164.00	3.83
169.00	3.84
174.00	3.85
179.00	3.86
184.00	3.87
189.00	3.88
194.00	3.89
199.00	3.90
204.00	3.90
209.00	3.91
214.00	3.92
219.00	3.93
224.00	3.94
229.00	3.95
234.00	3.96
239.00	3.97

244.00	3.98
249.00	3.99
254.00	4.00
259.00	4.01
264.00	4.02
269.00	4.04
274.00	4.05
279.00	4.06
284.00	4.07
289.00	4.08
294.00	4.09
299.00	4.10
304.00	4.11
309.00	4.12
314.00	4.13
319.00	4.15
324.00	4.16
329.00	4.17
334.00	4.18
339.00	4.19
344.00	4.20
349.00	4.22
354.00	4.23
359.00	4.24
364.00	4.25
369.00	4.27
374.00	4.28
379.00	4.29
384.00	4.30
389.00	4.32
394.00	4.33
399.00	4.34
404.00	4.36
409.00	4.37
414.00	4.38
419.00	4.40
424.00	4.41
429.00	4.43
434.00	4.44
439.00	4.46
444.00	4.47
449.00	4.48
454.00	4.50
459.00	4.51
464.00	4.53
469.00	4.54
474.00	4.56
479.00	4.58
484.00	4.59
489.00	4.61
494.00	4.62
499.00	4.64
504.00	4.66
509.00	4.67
514.00	4.69
519.00	4.71
524.00	4.72

529.00	4.74
534.00	4.76
539.00	4.78
544.00	4.80
549.00	4.81
554.00	4.83
559.00	4.85
564.00	4.87
569.00	4.89
574.00	4.91
579.00	4.93
584.00	4.95
589.00	4.97
594.00	4.99
599.00	5.01
604.00	5.03
609.00	5.05
614.00	5.07
619.00	5.10
624.00	5.12
629.00	5.14
634.00	5.16
639.00	5.19
644.00	5.21
649.00	5.23
654.00	5.26
659.00	5.28
664.00	5.31
669.00	5.33
674.00	5.36
679.00	5.38
684.00	5.41
689.00	5.44
694.00	5.46
699.00	5.49
704.00	5.52
709.00	5.55
714.00	5.58
719.00	5.60
724.00	5.63
729.00	5.66
734.00	5.70
739.00	5.73
744.00	5.76
749.00	5.79
754.00	5.82
759.00	5.86
764.00	5.89
769.00	5.93
774.00	5.96
779.00	6.00
784.00	6.04
789.00	6.07
794.00	6.11
799.00	6.15
804.00	6.19
809.00	6.23

814.00	6.27
819.00	6.32
824.00	6.36
829.00	6.41
834.00	6.45
839.00	6.50
844.00	6.54
849.00	6.59
854.00	6.64
859.00	6.69
864.00	6.75
869.00	6.80
874.00	6.85
879.00	6.91
884.00	6.97
889.00	7.03
894.00	7.09
899.00	7.15
904.00	7.22
909.00	7.28
914.00	7.35
919.00	7.42
924.00	7.49
929.00	7.57
934.00	7.64
939.00	7.72
944.00	7.81
949.00	7.89
954.00	7.98
959.00	8.07
964.00	8.16
969.00	8.26
974.00	8.36
979.00	8.47
984.00	8.58
989.00	8.69
994.00	8.81
999.00	8.94
1004.00	9.07
1009.00	9.21
1014.00	9.35
1019.00	9.50
1024.00	9.66
1029.00	9.83
1034.00	10.00
1039.00	10.19
1044.00	10.39
1049.00	10.60
1054.00	10.82
1059.00	11.06
1064.00	11.32
1069.00	11.60
1074.00	11.90
1079.00	12.23
1084.00	12.59
1089.00	13.16
1094.00	13.60

1099.00	14.09
1104.00	14.64
1109.00	15.47
1114.00	16.20
1119.00	17.27
1124.00	18.54
1129.00	19.81
1134.00	21.69
1139.00	24.47
1144.00	28.05
1149.00	34.31
1154.00	53.16
1159.00	53.63
1164.00	51.17
1169.00	45.82
1174.00	36.31
1179.00	16.57
1184.00	13.36
1189.00	11.64
1194.00	10.58
1199.00	9.79
1204.00	9.16
1209.00	8.65
1214.00	8.22
1219.00	7.85
1224.00	7.53
1229.00	7.24
1234.00	6.99
1239.00	6.77
1244.00	6.56
1249.00	6.37
1254.00	6.20
1259.00	6.05
1264.00	5.90
1269.00	5.77
1274.00	5.64
1279.00	5.52
1284.00	5.41
1289.00	5.31
1294.00	5.21
1299.00	5.12
1304.00	5.03
1309.00	4.95
1314.00	4.87
1319.00	4.80
1324.00	4.73
1329.00	4.66
1334.00	4.59
1339.00	4.53
1344.00	4.47
1349.00	4.41
1354.00	4.36
1359.00	4.31
1364.00	4.26
1369.00	4.21
1374.00	4.16
1379.00	4.11

1384.00	4.07
1389.00	4.03
1394.00	3.98
1399.00	3.94
1404.00	3.91
1409.00	3.87
1414.00	3.83
1419.00	3.80
1424.00	3.76
1429.00	3.73
1434.00	3.70
1439.00	3.66
1444.00	3.04
1449.00	2.27
1454.00	1.51
1459.00	0.75
1464.00	0.00
1469.00	0.00
1474.00	0.00
1479.00	0.00
1484.00	0.00

Initial Storage = 2.5300 (acre-ft))

Detention Basin Result Parameters

Routed Hydrograph

Peak Outflow Discharge: 23.396 (cfs), Time to Peak: 1179.00 (min), Total Outflow Volume: 644669.62 (ft^3)

Time (min)	Discharge (cfs)	Storage (acre-ft)
0.00	9.58	2.5300
24.00	8.90	2.3547
29.00	8.44	2.1949
34.00	7.97	2.0512
39.00	7.42	1.9255
44.00	6.94	1.8159
49.00	6.53	1.7204
54.00	6.17	1.6372
59.00	5.85	1.5645
64.00	5.57	1.5012
69.00	5.33	1.4462
74.00	5.13	1.3984
79.00	4.94	1.3569
84.00	4.79	1.3206
89.00	4.65	1.2892
94.00	4.53	1.2621
99.00	4.43	1.2387
104.00	4.34	1.2185
109.00	4.26	1.2012
114.00	4.20	1.1860
119.00	4.14	1.1731
124.00	4.09	1.1621
129.00	4.05	1.1527
134.00	4.02	1.1449
139.00	3.99	1.1384
144.00	3.96	1.1327
149.00	3.94	1.1280
154.00	3.92	1.1242
159.00	3.91	1.1212
164.00	3.90	1.1189
169.00	3.89	1.1171
174.00	3.89	1.1160
179.00	3.88	1.1152
184.00	3.88	1.1149
189.00	3.88	1.1149
194.00	3.88	1.1153
199.00	3.88	1.1158
204.00	3.88	1.1164
209.00	3.89	1.1171
214.00	3.89	1.1181
219.00	3.89	1.1193
224.00	3.90	1.1206
229.00	3.91	1.1221
234.00	3.91	1.1237
239.00	3.92	1.1254
244.00	3.93	1.1272

249.00	3.93	1.1291
254.00	3.94	1.1310
259.00	3.95	1.1331
264.00	3.96	1.1351
269.00	3.97	1.1376
274.00	3.98	1.1400
279.00	3.99	1.1425
284.00	4.00	1.1449
289.00	4.01	1.1474
294.00	4.02	1.1498
299.00	4.03	1.1523
304.00	4.04	1.1547
309.00	4.05	1.1572
314.00	4.06	1.1596
319.00	4.07	1.1624
324.00	4.08	1.1651
329.00	4.09	1.1678
334.00	4.10	1.1705
339.00	4.11	1.1731
344.00	4.12	1.1757
349.00	4.13	1.1787
354.00	4.14	1.1815
359.00	4.16	1.1843
364.00	4.17	1.1871
369.00	4.18	1.1901
374.00	4.19	1.1931
379.00	4.20	1.1960
384.00	4.21	1.1988
389.00	4.23	1.2019
394.00	4.24	1.2050
399.00	4.25	1.2079
404.00	4.26	1.2111
409.00	4.28	1.2142
414.00	4.29	1.2173
419.00	4.30	1.2205
424.00	4.31	1.2237
429.00	4.33	1.2271
434.00	4.34	1.2304
439.00	4.35	1.2339
444.00	4.37	1.2372
449.00	4.38	1.2405
454.00	4.40	1.2439
459.00	4.41	1.2472
464.00	4.42	1.2508
469.00	4.44	1.2542
474.00	4.45	1.2578
479.00	4.47	1.2615
484.00	4.48	1.2651
489.00	4.50	1.2689
494.00	4.51	1.2725
499.00	4.53	1.2762
504.00	4.54	1.2802
509.00	4.56	1.2839
514.00	4.57	1.2878
519.00	4.59	1.2918
524.00	4.60	1.2956
529.00	4.62	1.2996

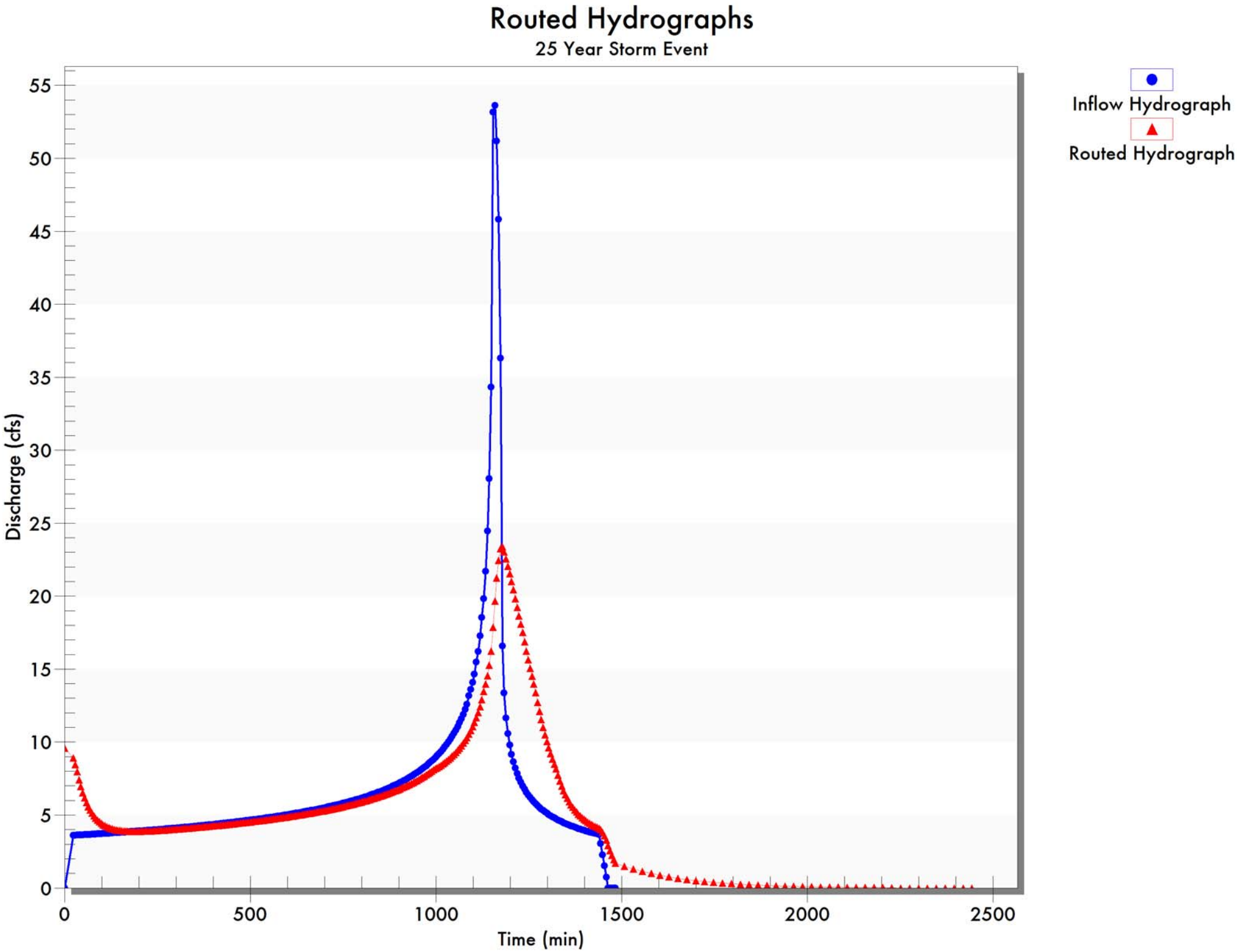
534.00	4.64	1.3037
539.00	4.65	1.3078
544.00	4.67	1.3121
549.00	4.69	1.3162
554.00	4.70	1.3203
559.00	4.72	1.3246
564.00	4.74	1.3289
569.00	4.76	1.3334
574.00	4.77	1.3378
579.00	4.79	1.3424
584.00	4.81	1.3470
589.00	4.83	1.3516
594.00	4.85	1.3563
599.00	4.87	1.3610
604.00	4.89	1.3657
609.00	4.91	1.3705
614.00	4.93	1.3752
619.00	4.95	1.3804
624.00	4.97	1.3854
629.00	4.99	1.3905
634.00	5.01	1.3956
639.00	5.03	1.4009
644.00	5.05	1.4062
649.00	5.07	1.4114
654.00	5.09	1.4170
659.00	5.12	1.4224
664.00	5.14	1.4281
669.00	5.16	1.4337
674.00	5.18	1.4395
679.00	5.21	1.4452
684.00	5.23	1.4511
689.00	5.26	1.4572
694.00	5.28	1.4632
699.00	5.30	1.4693
704.00	5.33	1.4756
709.00	5.36	1.4821
714.00	5.38	1.4886
719.00	5.41	1.4950
724.00	5.43	1.5015
729.00	5.46	1.5081
734.00	5.49	1.5151
739.00	5.52	1.5221
744.00	5.55	1.5292
749.00	5.57	1.5364
754.00	5.60	1.5435
759.00	5.63	1.5510
764.00	5.66	1.5585
769.00	5.69	1.5663
774.00	5.73	1.5741
779.00	5.76	1.5821
784.00	5.79	1.5903
789.00	5.82	1.5985
794.00	5.86	1.6068
799.00	5.89	1.6154
804.00	5.93	1.6241
809.00	5.96	1.6329
814.00	6.00	1.6419

819.00	6.04	1.6513
824.00	6.07	1.6608
829.00	6.11	1.6706
834.00	6.15	1.6804
839.00	6.19	1.6905
844.00	6.23	1.7006
849.00	6.28	1.7110
854.00	6.32	1.7217
859.00	6.36	1.7325
864.00	6.41	1.7438
869.00	6.45	1.7553
874.00	6.50	1.7669
879.00	6.55	1.7788
884.00	6.60	1.7912
889.00	6.65	1.8038
894.00	6.70	1.8167
899.00	6.75	1.8299
904.00	6.81	1.8435
909.00	6.86	1.8573
914.00	6.92	1.8716
919.00	6.98	1.8862
924.00	7.04	1.9012
929.00	7.10	1.9167
934.00	7.16	1.9325
939.00	7.23	1.9487
944.00	7.30	1.9657
949.00	7.37	1.9831
954.00	7.44	2.0011
959.00	7.51	2.0195
964.00	7.59	2.0385
969.00	7.66	2.0582
974.00	7.75	2.0785
979.00	7.83	2.0996
984.00	7.92	2.1215
989.00	8.01	2.1441
994.00	8.10	2.1675
999.00	8.18	2.1926
1004.00	8.25	2.2196
1009.00	8.33	2.2486
1014.00	8.41	2.2796
1019.00	8.50	2.3126
1024.00	8.60	2.3478
1029.00	8.70	2.3853
1034.00	8.80	2.4249
1039.00	8.91	2.4671
1044.00	9.03	2.5119
1049.00	9.16	2.5595
1054.00	9.30	2.6098
1059.00	9.44	2.6634
1064.00	9.59	2.7206
1069.00	9.75	2.7816
1074.00	9.93	2.8468
1079.00	10.11	2.9167
1084.00	10.31	2.9920
1089.00	10.54	3.0787
1094.00	10.78	3.1718
1099.00	11.05	3.2723

1104.00	11.34	3.3814
1109.00	11.66	3.5073
1114.00	12.03	3.6453
1119.00	12.44	3.8051
1124.00	12.91	3.9912
1129.00	13.46	4.2012
1134.00	13.97	4.4564
1139.00	14.53	4.7849
1144.00	15.25	5.2079
1149.00	16.24	5.8053
1154.00	17.86	6.9722
1159.00	19.66	8.0951
1164.00	21.24	9.0847
1169.00	22.44	9.8577
1174.00	23.26	10.2892
1179.00	23.40	10.0635
1184.00	23.03	9.7454
1189.00	22.56	9.4051
1194.00	22.06	9.0349
1199.00	21.54	8.6510
1204.00	21.00	8.2611
1209.00	20.44	7.8714
1214.00	19.83	7.4875
1219.00	19.23	7.1112
1224.00	18.65	6.7436
1229.00	18.08	6.3853
1234.00	17.52	6.0372
1239.00	16.86	5.7035
1244.00	16.24	5.3836
1249.00	15.63	5.0774
1254.00	15.06	4.7846
1259.00	14.51	4.5050
1264.00	13.98	4.2379
1269.00	13.40	3.9858
1274.00	12.73	3.7515
1279.00	12.11	3.5338
1284.00	11.53	3.3316
1289.00	10.99	3.1438
1294.00	10.49	2.9692
1299.00	10.03	2.8069
1304.00	9.60	2.6560
1309.00	9.20	2.5156
1314.00	8.82	2.3849
1319.00	8.48	2.2634
1324.00	8.15	2.1502
1329.00	7.72	2.0490
1334.00	7.33	1.9584
1339.00	6.98	1.8773
1344.00	6.67	1.8045
1349.00	6.39	1.7390
1354.00	6.14	1.6802
1359.00	5.91	1.6272
1364.00	5.71	1.5793
1369.00	5.52	1.5359
1374.00	5.35	1.4964
1379.00	5.20	1.4603
1384.00	5.06	1.4275

1389.00	4.93	1.3976
1394.00	4.82	1.3699
1399.00	4.71	1.3445
1404.00	4.61	1.3213
1409.00	4.52	1.2997
1414.00	4.44	1.2797
1419.00	4.36	1.2612
1424.00	4.29	1.2439
1429.00	4.22	1.2277
1434.00	4.15	1.2127
1439.00	4.10	1.1983
1444.00	4.00	1.1665
1449.00	3.83	1.1149
1454.00	3.59	1.0462
1459.00	3.28	0.9626
1464.00	2.91	0.8662
1469.00	2.55	0.7820
1474.00	2.23	0.7083
1479.00	1.95	0.6439
1484.00	1.70	0.5876
1508.00	1.49	0.5384
1532.00	1.30	0.4953
1556.00	1.14	0.4577
1580.00	1.00	0.4248
1604.00	0.87	0.3960
1628.00	0.76	0.3709
1652.00	0.67	0.3489
1676.00	0.58	0.3296
1700.00	0.51	0.3128
1724.00	0.44	0.2981
1748.00	0.39	0.2853
1772.00	0.34	0.2740
1796.00	0.30	0.2642
1820.00	0.26	0.2556
1844.00	0.23	0.2481
1868.00	0.20	0.2415
1892.00	0.17	0.2358
1916.00	0.15	0.2307
1940.00	0.13	0.2263
1964.00	0.12	0.2225
1988.00	0.10	0.2191
2012.00	0.09	0.2162
2036.00	0.08	0.2136
2060.00	0.07	0.2114
2084.00	0.06	0.2094
2108.00	0.05	0.2077
2132.00	0.05	0.2062
2156.00	0.04	0.2049
2180.00	0.03	0.2038
2204.00	0.03	0.2028
2228.00	0.03	0.2019
2252.00	0.00	0.0000
2276.00	0.00	0.0000
2300.00	0.00	0.0000
2324.00	0.00	0.0000
2348.00	0.00	0.0000
2372.00	0.00	0.0000

2396.00	0.00	0.0000
2420.00	0.00	0.0000
2444.00	0.00	0.0000


Routed Hydrographs
25 Year Storm Event
Discharge (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
50
55
0
500
1000
1500
2000
2500
Inflow Hydrograph
Routed Hydrograph

Hydraulic Analysis Report

Project Data

Project Title: 30850 - Brookfield Lincoln

Designer:

Project Date: Thursday, February 20, 2014

Project Units: U.S. Customary Units

Notes:

Detention Basin Analysis: 50 Year Detention Basin Analysis

Notes:

Storage Input Parameters

Storage Capacity: Known geometry

Length: 250.0000 (ft)

Width: 210.0000 (ft)

Depth: 10.0000 (ft)

Side slope: 0.0000 (ft/ft)

Base elevation: 0.0000 (ft)

Discharge Input Parameters

Outlet: Outlet 1"""""""

Outlet Type: Circular

Diameter: 1.5000 (ft)

Height above base: 0.0000 (ft)

Manning's n: 0.0130

Slope: 0.0100 (ft/ft)

Orifice Coefficient: 0.6000

Base Elevation: 0.0000 (ft)

Storage & Discharge Input Parameters

Elevation - Storage - Discharge

Elevation (ft)	Storage (acre-ft)	Discharge (cfs)
0.00	0.00	0.00
1.67	2.01	8.15
3.33	4.02	13.68
5.00	6.03	17.54
6.67	8.03	20.70
8.33	10.04	23.43
10.00	12.05	25.88

Detention Basin Input Parameters

Inflow Hydrograph

Peak Inflow Discharge: 64.180 (cfs), Time to Peak: 1157.00 (min), Total Inflow Volume: 680012.70 (ft^3)

Time (min)	Discharge (cfs)
0.00	0.00
22.00	4.07
27.00	4.07
32.00	4.08
37.00	4.09
42.00	4.10
47.00	4.11
52.00	4.12
57.00	4.13
62.00	4.13
67.00	4.14
72.00	4.15
77.00	4.16
82.00	4.17
87.00	4.18
92.00	4.19
97.00	4.20
102.00	4.21
107.00	4.22
112.00	4.23
117.00	4.24
122.00	4.25
127.00	4.25
132.00	4.26
137.00	4.27
142.00	4.28
147.00	4.29
152.00	4.30
157.00	4.31
162.00	4.32
167.00	4.33
172.00	4.34
177.00	4.35
182.00	4.37
187.00	4.38
192.00	4.39
197.00	4.40
202.00	4.41
207.00	4.42
212.00	4.43
217.00	4.44
222.00	4.45
227.00	4.46
232.00	4.47
237.00	4.49

242.00	4.50
247.00	4.51
252.00	4.52
257.00	4.53
262.00	4.54
267.00	4.56
272.00	4.57
277.00	4.58
282.00	4.59
287.00	4.60
292.00	4.62
297.00	4.63
302.00	4.64
307.00	4.65
312.00	4.67
317.00	4.68
322.00	4.69
327.00	4.71
332.00	4.72
337.00	4.73
342.00	4.75
347.00	4.76
352.00	4.77
357.00	4.79
362.00	4.80
367.00	4.82
372.00	4.83
377.00	4.84
382.00	4.86
387.00	4.87
392.00	4.89
397.00	4.90
402.00	4.92
407.00	4.93
412.00	4.95
417.00	4.97
422.00	4.98
427.00	5.00
432.00	5.01
437.00	5.03
442.00	5.05
447.00	5.06
452.00	5.08
457.00	5.10
462.00	5.11
467.00	5.13
472.00	5.15
477.00	5.16
482.00	5.18
487.00	5.20
492.00	5.22
497.00	5.24
502.00	5.26
507.00	5.27
512.00	5.29
517.00	5.31
522.00	5.33

527.00	5.35
532.00	5.37
537.00	5.39
542.00	5.41
547.00	5.43
552.00	5.45
557.00	5.47
562.00	5.50
567.00	5.52
572.00	5.54
577.00	5.56
582.00	5.58
587.00	5.61
592.00	5.63
597.00	5.65
602.00	5.68
607.00	5.70
612.00	5.73
617.00	5.75
622.00	5.77
627.00	5.80
632.00	5.83
637.00	5.85
642.00	5.88
647.00	5.90
652.00	5.93
657.00	5.96
662.00	5.99
667.00	6.02
672.00	6.04
677.00	6.07
682.00	6.10
687.00	6.13
692.00	6.16
697.00	6.19
702.00	6.23
707.00	6.26
712.00	6.29
717.00	6.32
722.00	6.36
727.00	6.39
732.00	6.43
737.00	6.46
742.00	6.50
747.00	6.53
752.00	6.57
757.00	6.61
762.00	6.65
767.00	6.69
772.00	6.73
777.00	6.77
782.00	6.81
787.00	6.85
792.00	6.90
797.00	6.94
802.00	6.98
807.00	7.03

812.00	7.08
817.00	7.12
822.00	7.17
827.00	7.22
832.00	7.28
837.00	7.33
842.00	7.38
847.00	7.44
852.00	7.49
857.00	7.55
862.00	7.61
867.00	7.67
872.00	7.73
877.00	7.79
882.00	7.86
887.00	7.92
892.00	7.99
897.00	8.06
902.00	8.14
907.00	8.21
912.00	8.29
917.00	8.36
922.00	8.45
927.00	8.53
932.00	8.62
937.00	8.71
942.00	8.80
947.00	8.89
952.00	8.99
957.00	9.09
962.00	9.20
967.00	9.31
972.00	9.42
977.00	9.54
982.00	9.66
987.00	9.79
992.00	9.93
997.00	10.07
1002.00	10.21
1007.00	10.37
1012.00	10.53
1017.00	10.69
1022.00	10.87
1027.00	11.06
1032.00	11.25
1037.00	11.46
1042.00	11.68
1047.00	11.92
1052.00	12.17
1057.00	12.44
1062.00	12.73
1067.00	13.21
1072.00	13.55
1077.00	13.92
1082.00	14.32
1087.00	14.96
1092.00	15.45

1097.00	16.00
1102.00	16.83
1107.00	17.53
1112.00	18.58
1117.00	19.53
1122.00	20.92
1127.00	22.30
1132.00	24.63
1137.00	26.94
1142.00	30.56
1147.00	36.75
1152.00	57.82
1157.00	64.18
1162.00	61.77
1167.00	56.11
1172.00	43.83
1177.00	19.49
1182.00	15.60
1187.00	13.54
1192.00	12.12
1197.00	11.19
1202.00	10.46
1207.00	9.86
1212.00	9.36
1217.00	8.93
1222.00	8.56
1227.00	8.24
1232.00	7.95
1237.00	7.69
1242.00	7.45
1247.00	7.24
1252.00	7.04
1257.00	6.86
1262.00	6.70
1267.00	6.54
1272.00	6.40
1277.00	6.26
1282.00	6.14
1287.00	6.02
1292.00	5.91
1297.00	5.80
1302.00	5.70
1307.00	5.61
1312.00	5.52
1317.00	5.44
1322.00	5.35
1327.00	5.28
1332.00	5.20
1337.00	5.13
1342.00	5.06
1347.00	5.00
1352.00	4.94
1357.00	4.88
1362.00	4.82
1367.00	4.76
1372.00	4.71
1377.00	4.66

1382.00	4.61
1387.00	4.56
1392.00	4.51
1397.00	4.46
1402.00	4.42
1407.00	4.38
1412.00	4.34
1417.00	4.29
1422.00	4.26
1427.00	4.22
1432.00	4.18
1437.00	4.14
1442.00	3.74
1447.00	2.79
1452.00	1.86
1457.00	0.92
1462.00	0.00
1467.00	0.00
1472.00	0.00
1477.00	0.00
1482.00	0.00

Initial Storage = 2.5300 (acre-ft))

Detention Basin Result Parameters

Routed Hydrograph

Peak Outflow Discharge: 25.090 (cfs), Time to Peak: 1177.00 (min), Total Outflow Volume: 730314.79 (ft^3)

Time (min)	Discharge (cfs)	Storage (acre-ft)
0.00	9.58	2.5300
22.00	8.98	2.3813
27.00	8.58	2.2445
32.00	8.22	2.1190
37.00	7.78	2.0072
42.00	7.35	1.9087
47.00	6.98	1.8218
52.00	6.64	1.7453
57.00	6.35	1.6779
62.00	6.10	1.6184
67.00	5.87	1.5660
72.00	5.67	1.5200
77.00	5.49	1.4796
82.00	5.34	1.4441
87.00	5.20	1.4131
92.00	5.09	1.3859
97.00	4.98	1.3621
102.00	4.89	1.3414
107.00	4.81	1.3234
112.00	4.75	1.3077
117.00	4.69	1.2942
122.00	4.64	1.2825
127.00	4.59	1.2721
132.00	4.55	1.2633
137.00	4.52	1.2557
142.00	4.49	1.2493
147.00	4.47	1.2440
152.00	4.45	1.2395
157.00	4.43	1.2358
162.00	4.42	1.2329
167.00	4.41	1.2306
172.00	4.40	1.2288
177.00	4.39	1.2275
182.00	4.39	1.2270
187.00	4.39	1.2268
192.00	4.39	1.2269
197.00	4.39	1.2272
202.00	4.39	1.2278
207.00	4.39	1.2287
212.00	4.40	1.2297
217.00	4.40	1.2309
222.00	4.41	1.2322
227.00	4.41	1.2337
232.00	4.42	1.2353
237.00	4.42	1.2372
242.00	4.43	1.2393

247.00	4.44	1.2413
252.00	4.45	1.2435
257.00	4.46	1.2456
262.00	4.47	1.2478
267.00	4.48	1.2503
272.00	4.49	1.2529
277.00	4.50	1.2554
282.00	4.51	1.2579
287.00	4.52	1.2604
292.00	4.53	1.2631
297.00	4.54	1.2659
302.00	4.55	1.2686
307.00	4.56	1.2713
312.00	4.57	1.2742
317.00	4.58	1.2771
322.00	4.60	1.2799
327.00	4.61	1.2830
332.00	4.62	1.2860
337.00	4.63	1.2890
342.00	4.65	1.2921
347.00	4.66	1.2952
352.00	4.67	1.2983
357.00	4.68	1.3015
362.00	4.70	1.3047
367.00	4.71	1.3080
372.00	4.72	1.3113
377.00	4.74	1.3144
382.00	4.75	1.3178
387.00	4.76	1.3211
392.00	4.78	1.3245
397.00	4.79	1.3279
402.00	4.80	1.3314
407.00	4.82	1.3348
412.00	4.83	1.3384
417.00	4.85	1.3421
422.00	4.86	1.3457
427.00	4.88	1.3494
432.00	4.89	1.3530
437.00	4.91	1.3568
442.00	4.92	1.3607
447.00	4.94	1.3644
452.00	4.95	1.3683
457.00	4.97	1.3722
462.00	4.98	1.3761
467.00	5.00	1.3800
472.00	5.02	1.3841
477.00	5.03	1.3879
482.00	5.05	1.3919
487.00	5.06	1.3960
492.00	5.08	1.4002
497.00	5.10	1.4045
502.00	5.12	1.4089
507.00	5.13	1.4130
512.00	5.15	1.4172
517.00	5.17	1.4215
522.00	5.19	1.4259
527.00	5.20	1.4304

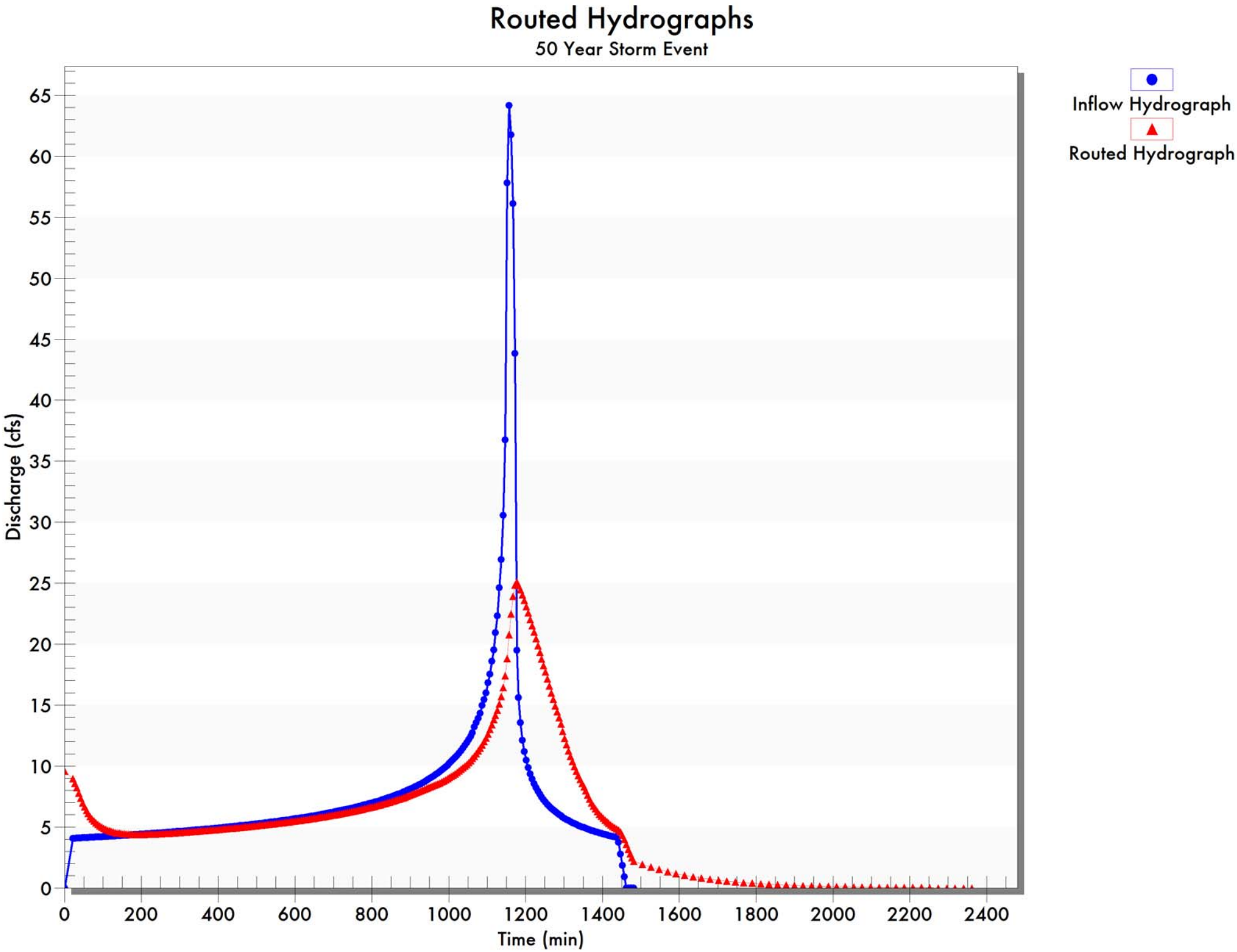
532.00	5.22	1.4349
537.00	5.24	1.4394
542.00	5.26	1.4440
547.00	5.28	1.4487
552.00	5.30	1.4533
557.00	5.31	1.4580
562.00	5.33	1.4630
567.00	5.35	1.4681
572.00	5.38	1.4730
577.00	5.40	1.4780
582.00	5.42	1.4830
587.00	5.44	1.4883
592.00	5.46	1.4935
597.00	5.48	1.4987
602.00	5.50	1.5041
607.00	5.52	1.5095
612.00	5.54	1.5151
617.00	5.57	1.5207
622.00	5.59	1.5261
627.00	5.61	1.5318
632.00	5.64	1.5377
637.00	5.66	1.5435
642.00	5.68	1.5495
647.00	5.71	1.5553
652.00	5.73	1.5613
657.00	5.76	1.5675
662.00	5.78	1.5738
667.00	5.81	1.5803
672.00	5.83	1.5866
677.00	5.86	1.5930
682.00	5.88	1.5995
687.00	5.91	1.6061
692.00	5.94	1.6128
697.00	5.97	1.6196
702.00	5.99	1.6268
707.00	6.02	1.6339
712.00	6.05	1.6411
717.00	6.08	1.6484
722.00	6.11	1.6559
727.00	6.14	1.6634
732.00	6.17	1.6712
737.00	6.20	1.6789
742.00	6.24	1.6869
747.00	6.27	1.6948
752.00	6.30	1.7030
757.00	6.33	1.7113
762.00	6.37	1.7198
767.00	6.40	1.7285
772.00	6.44	1.7373
777.00	6.48	1.7463
782.00	6.51	1.7553
787.00	6.55	1.7644
792.00	6.59	1.7739
797.00	6.62	1.7835
802.00	6.66	1.7931
807.00	6.70	1.8030
812.00	6.74	1.8131

817.00	6.79	1.8233
822.00	6.83	1.8337
827.00	6.87	1.8443
832.00	6.91	1.8554
837.00	6.96	1.8667
842.00	7.00	1.8780
847.00	7.05	1.8898
852.00	7.10	1.9016
857.00	7.15	1.9138
862.00	7.20	1.9263
867.00	7.25	1.9390
872.00	7.30	1.9520
877.00	7.35	1.9652
882.00	7.41	1.9789
887.00	7.46	1.9927
892.00	7.52	2.0069
897.00	7.58	2.0214
902.00	7.64	2.0366
907.00	7.70	2.0520
912.00	7.77	2.0679
917.00	7.83	2.0839
922.00	7.90	2.1007
927.00	7.97	2.1178
932.00	8.04	2.1355
937.00	8.11	2.1537
942.00	8.17	2.1727
947.00	8.23	2.1928
952.00	8.28	2.2143
957.00	8.34	2.2369
962.00	8.41	2.2609
967.00	8.48	2.2862
972.00	8.55	2.3126
977.00	8.62	2.3404
982.00	8.70	2.3695
987.00	8.78	2.4001
992.00	8.87	2.4322
997.00	8.96	2.4659
1002.00	9.05	2.5009
1007.00	9.15	2.5378
1012.00	9.26	2.5764
1017.00	9.36	2.6166
1022.00	9.48	2.6587
1027.00	9.60	2.7031
1032.00	9.72	2.7494
1037.00	9.85	2.7981
1042.00	9.99	2.8493
1047.00	10.14	2.9034
1052.00	10.29	2.9604
1057.00	10.45	3.0207
1062.00	10.62	3.0846
1067.00	10.81	3.1574
1072.00	11.01	3.2342
1077.00	11.23	3.3157
1082.00	11.46	3.4022
1087.00	11.72	3.5005
1092.00	12.00	3.6051
1097.00	12.30	3.7173

1102.00	12.63	3.8447
1107.00	12.99	3.9823
1112.00	13.40	4.1394
1117.00	13.80	4.3131
1122.00	14.16	4.5179
1127.00	14.58	4.7517
1132.00	15.09	5.0408
1137.00	15.69	5.3816
1142.00	16.43	5.8097
1147.00	17.41	6.3958
1152.00	18.82	7.5775
1157.00	20.77	8.8929
1162.00	22.48	10.0836
1167.00	23.90	11.0597
1172.00	24.84	11.6351
1177.00	25.09	11.4654
1182.00	24.82	11.1861
1187.00	24.45	10.8757
1192.00	24.02	10.5301
1197.00	23.58	10.1621
1202.00	23.08	9.7833
1207.00	22.55	9.3997
1212.00	22.03	9.0158
1217.00	21.51	8.6345
1222.00	20.99	8.2577
1227.00	20.45	7.8876
1232.00	19.88	7.5261
1237.00	19.32	7.1737
1242.00	18.77	6.8306
1247.00	18.24	6.4972
1252.00	17.72	6.1735
1257.00	17.15	5.8615
1262.00	16.57	5.5625
1267.00	16.00	5.2758
1272.00	15.46	5.0011
1277.00	14.95	4.7379
1282.00	14.45	4.4861
1287.00	13.98	4.2450
1292.00	13.46	4.0163
1297.00	12.85	3.8027
1302.00	12.28	3.6033
1307.00	11.75	3.4172
1312.00	11.25	3.2434
1317.00	10.79	3.0812
1322.00	10.36	2.9294
1327.00	9.96	2.7877
1332.00	9.58	2.6550
1337.00	9.23	2.5309
1342.00	8.89	2.4147
1347.00	8.59	2.3061
1352.00	8.30	2.2044
1357.00	7.97	2.1107
1362.00	7.61	2.0262
1367.00	7.28	1.9498
1372.00	6.99	1.8808
1377.00	6.72	1.8183
1382.00	6.48	1.7617

1387.00	6.26	1.7102
1392.00	6.06	1.6632
1397.00	5.88	1.6202
1402.00	5.71	1.5811
1407.00	5.56	1.5453
1412.00	5.42	1.5126
1417.00	5.29	1.4822
1422.00	5.17	1.4545
1427.00	5.07	1.4288
1432.00	4.97	1.4050
1437.00	4.87	1.3828
1442.00	4.76	1.3517
1447.00	4.59	1.2971
1452.00	4.33	1.2223
1457.00	3.99	1.1293
1462.00	3.58	1.0208
1467.00	3.17	0.9249
1472.00	2.80	0.8401
1477.00	2.47	0.7651
1482.00	2.19	0.6988
1504.00	1.94	0.6402
1526.00	1.71	0.5883
1548.00	1.51	0.5425
1570.00	1.34	0.5019
1592.00	1.18	0.4661
1614.00	1.05	0.4344
1636.00	0.92	0.4064
1658.00	0.82	0.3816
1680.00	0.72	0.3597
1702.00	0.64	0.3403
1724.00	0.57	0.3232
1746.00	0.50	0.3080
1768.00	0.44	0.2946
1790.00	0.39	0.2828
1812.00	0.35	0.2723
1834.00	0.31	0.2631
1856.00	0.27	0.2549
1878.00	0.24	0.2476
1900.00	0.21	0.2412
1922.00	0.19	0.2356
1944.00	0.17	0.2306
1966.00	0.15	0.2261
1988.00	0.13	0.2222
2010.00	0.11	0.2188
2032.00	0.10	0.2157
2054.00	0.09	0.2130
2076.00	0.08	0.2106
2098.00	0.07	0.2085
2120.00	0.06	0.2066
2142.00	0.05	0.2050
2164.00	0.05	0.2035
2186.00	0.04	0.2022
2208.00	0.04	0.2011
2230.00	0.03	0.2001
2252.00	0.03	0.1992
2274.00	0.00	0.0000
2296.00	0.00	0.0000

2318.00	0.00	0.0000
2340.00	0.00	0.0000
2362.00	0.00	0.0000


Routed Hydrographs
50 Year Storm Event
Inflow Hydrograph
Routed Hydrograph
Discharge (cfs)
Time (min)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400

APPENDIX F

Existing LID Results

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelle	1A	7	0.2	LID	17	1170	0.016	1	30	0.26	0.1	0.26	0.47	0.15
Nelle	2B	5.6	0.75	LID	17	1240	0.019	1	30	0.26	0.1	0.7	1.02	0.32
Nelle	3C	3.3	0.75	LID	17	881	0.017	1	30	0.26	0.1	0.7	0.60	0.19
Nelle	5C	11.4	0.5	LID	17	1059	0.019	1	30	0.26	0.1	0.5	1.48	0.47
Nelle	7C	3.6	0.8	LID	17	352	0.014	1	20	0.31	0.1	0.74	0.83	0.22
Nelle	8A	10.6	0.25	LID	17	1320	0.017	1	30	0.26	0.1	0.3	0.83	0.26
Nelle	9D	14.9	0.4	LID	17	1062	0.028	1	30	0.26	0.1	0.42	1.63	0.51
Nelle	12A	4.3	0.2	LID	17	500	0.019	1	30	0.26	0.1	0.26	0.29	0.09
Nelle	13E	12.2	0.2	LID	17	1156	0.025	1	30	0.26	0.1	0.26	0.82	0.26
*Nelle	F	3.6	0.8	LID	17	792	0.008	1	30	0.26	0.1	0.74	0.69	0.22
Total (not including Area F)		**72.9**										**Total**	**7.97**	**2.47**

Parkway draining to Sorensen Ave	0.4
Total Acerage	**76.9**

* Subarea F flows towards Sorensen Avenue and is not included in the total flow rate and volume.

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelles	A	42.2	0.79	LID	16	2933	0.01	1	30	0.26	0.1	0.73	8.01	2.53
Nelles	B	34.7	0.74	LID	17	2484	0.01	1	30	0.26	0.1	0.69	6.23	1.97
	Total	**76.9**										**Total**	**14.24**	**4.50**

Proposed Development LID Results (1.5 Factor for Bioretention)

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)
Nelles	A	42.2	0.79	LID	16	2933	0.01	1.5	30	0.39	0.1	0.73	12.01	3.80
Nelles	B	34.7	0.74	LID	17	2484	0.01	1.5	30	0.39	0.3	0.73	9.88	2.97
	Total	**76.9**										**Total**	**21.89**	**6.77**

Proposed Development LID Volume & Flow Rate Results (Infiltration)

																Infiltration BMP Sizing					
Drainage Area	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)	**Volume (cu. ft.)**	Percolation Rate (Pdesign=in/hr)	Fill Time (hrs)	Drain Time (hrs)	Max Ponding Depth (ft)	Design Ponding Depth (ft)	**Infiltrating Surface Area Needed (sq.ft.)**
A	A1	14.6	0.96	LID	16	2933	0.0100	1.0	30	0.26	0.10	0.73	8.01	2.53	**110207**	0.50	2.00	72.00	3.00	3.00	**35743**
	A2	1.0	0.96																		
	A3	4.6	0.96																		
	A4	0.6	0.96																		
	A5	5.0	0.74																		
	A6	3.3	0.74																		
	A7	1.0	0.96																		
	A8	3.9	0.74																		
	A9	4.5	0.10																		
	A10	3.7	0.74																		
B	B1	10.3	0.74	LID	17	2484	0.0100	1.0	30	0.26	0.10	0.69	6.23	1.97	**85813**	0.50	2.00	72.00	3.00	3.00	**27831**
	B2	3.6	0.74																		
	B3	7.8	0.74																		
	B4	4.5	0.74																		
	B5	8.5	0.74																		

Proposed Development LID Volume & Flow Rate Results (1.5 Multiplier for Biofiltration)

																Bioretention With Underdrain Sizing				
Drainage Area	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flow rate (cfs)	Volume (acre-ft)	**Volume (cu. ft.)**	Percolation Rate (Pdesign=in/hr)	Ponding Depth (ft)	Planting Media Depth (ft)	Drawdown Time (hrs)	**Surface Area Needed (sq.ft.)**
A	A1	14.6	0.96	LID	16	2933	0.0100	1.5	30	0.39	0.10	0.73	12.01	3.80	**165528**	2.50	1.50	2.00	16.80	**27025**
	A2	1.0	0.96																	
	A3	4.6	0.96																	
	A4	0.6	0.96																	
	A5	5.0	0.74																	
	A6	3.3	0.74																	
	A7	1.0	0.96																	
	A8	3.9	0.74																	
	A9	4.5	0.10																	
	A10	3.7	0.74																	
B	B1	10.3	0.74	LID	17	2484	0.0100	1.5	30	0.39	0.26	0.73	9.88	2.97	**129373**	2.50	1.50	2.00	16.80	**21122**
	B2	3.6	0.74																	
	B3	7.8	0.74																	
	B4	4.5	0.74																	
	B5	8.5	0.74																	

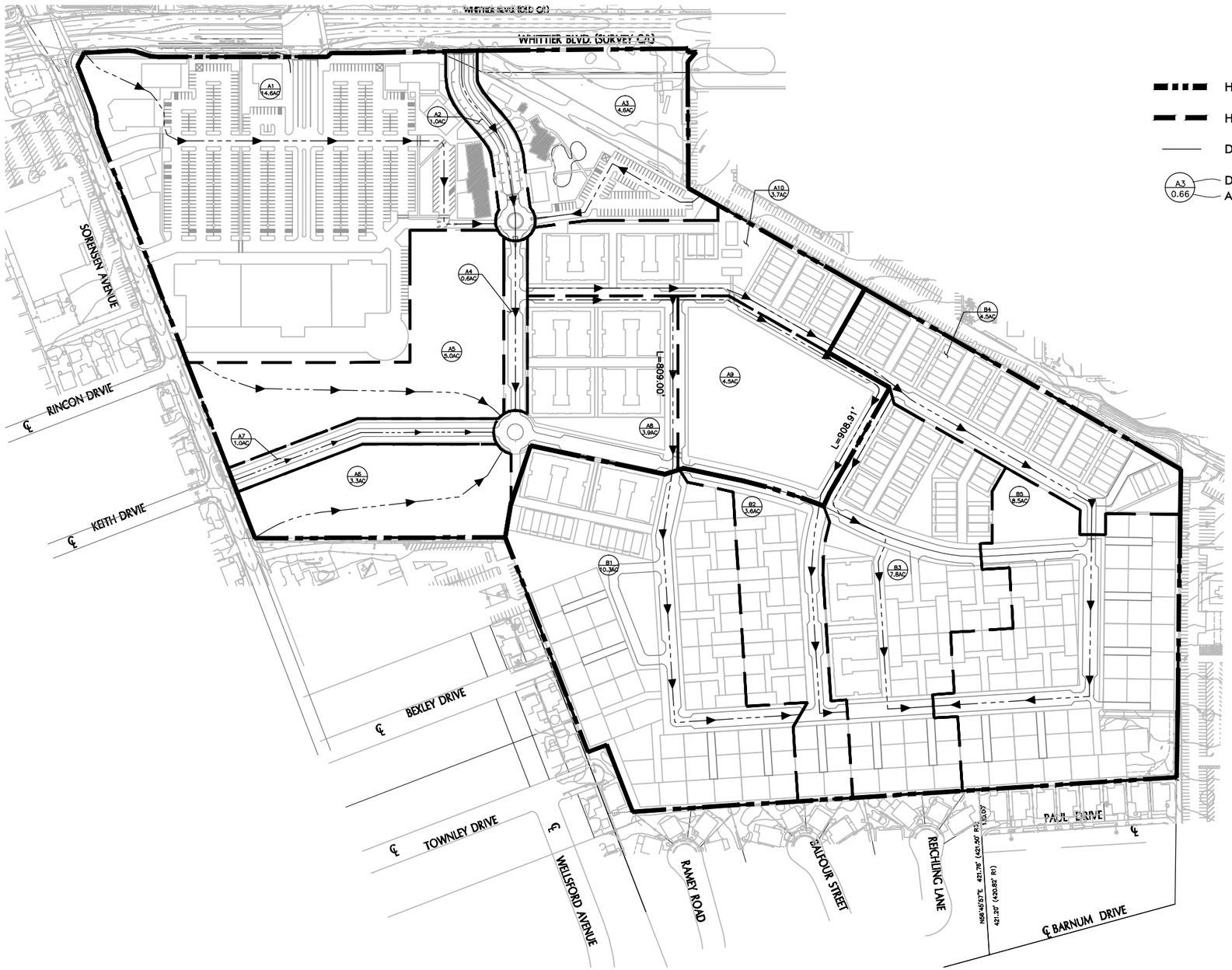
LID INFILTRATION ALTERNATIVE #1 SUMMARY

DRAINAGE AREA	ACREAGE	IMPERVIOUS %	SWQDv (INFILTRATION)	REQUIRED TREATMENT	PROPOSED TREATMENT BMP	BMP TREATMENT PROVIDED
A	42.2	79%	110207	35743 SF Infiltrating Surface Area	1 Subsurface Infiltration Gallery	36,000 ft^2 Infiltrating Surface Area
B	34.7	74%	85813	27831 SF Infiltrating Surface Area	2 Subsurface Infiltration Gallery 3 Subsurface Infiltration Gallery 4 Subsurface Infiltration Gallery	10,000 ft^2 Infiltrating Surface Area 10,000 ft^2 Infiltrating Surface Area 10,000 ft^2 Infiltrating Surface Area

LID BIORETENTION ALTERNATIVE #2 SUMMARY

DRAINAGE AREA	ACREAGE	IMPERVIOUS %	SWQDv * 1.5 (BIOFILTRATION)	SWQDf * 1.5 (BIOFILTRATION)	REQUIRED TREATMENT	PROPOSED TREATMENT	BMP TREATMENT PROVIDED
A	42.2	79%	165528	12.01	27025 SF Bioretention Surface Area OR 12.01 cfs	Modular Flow-through Bioretention	12.01 cfs
B	34.7	74%	129373	9.88	21122 SF Bioretention Surface Area OR 9.88 cfs	Modular Flow-through Bioretention 1 Bioretention with Underdrain 2 Bioretention with Underdrain 3 Bioretention with Underdrain	2.86 cfs 5,000 ft^2 Bioretention Surface Area 5,000 ft^2 Bioretention Surface Area 5,000 ft^2 Bioretention Surface Area

APPENDIX G



LEGEND

- HYDROLOGY BROUNDARY
- HYDROLOGY SUB AREA BROUNDARY
- DIRECTION OF FLOW (STORM DRAIN)
- A3 / 0.66 — DRAINAGE AREA ID / ACREAGE

300' 0' 150' 300' 600'

SCALE: 1" = 300'

FUSCOE ENGINEERING
16795 Von Karman, Suite 100
Irvine, California 92606
tel 949.474.1960 ° fax 949.474.5315
www.fuscoe.com

N

Scale: 1" = 300'
Exhibit Date: 3/21/2013

PROPOSED CONDITION DRAINAGE MANAGEMENT AREA EXHIBIT BROOKFIELD - LINCOLN WHITTIER, CA

LEGEND

- HYDROLOGY BROUNDARY
- HYDROLOGY SUB AREA BROUNDARY
- DIRECTION OF FLOW (STORM DRAIN)
- INFILTRATION BASIN
- A3 / 0.66 — DRAINAGE AREA ID / ACREAGE
- 4 — BASIN NUMBER

DRAINAGE AREA	ACREAGE	IMPERVIOUS %	SWQDv (INFILTRATION)	REQUIRED TREATMENT	PROPOSED TREATMENT BMP	BMP TREATMENT PROVIDED
A	42.2	79%	110207	35743 SF Infiltrating Surface Area	1 Subsurface Infiltration Gallery	36,000 ft^2 Infiltrating Surface Area
B	34.7	74%	85813	27831 SF Infiltrating Surface Area	2 Subsurface Infiltration Gallery	10,000 ft^2 Infiltrating Surface Area
					3 Subsurface Infiltration Gallery	10,000 ft^2 Infiltrating Surface Area
					4 Subsurface Infiltration Gallery	10,000 ft^2 Infiltrating Surface Area

300' 0' 150' 300' 600'

SCALE: 1" = 300'

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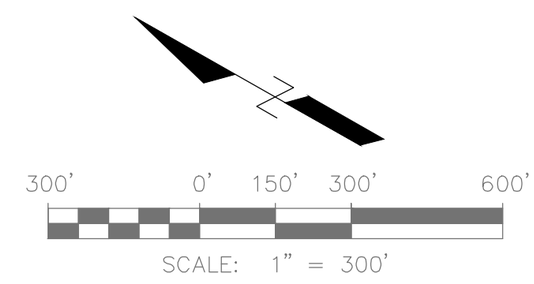
Scale: 1" = 300'
Exhibit Date: 3/21/2013

CONCEPTUAL LID BMP EXHIBIT ALT #1 BROOKFIELD - LINCOLN WHITTIER, CA

LEGEND

- HYDROLOGY BROUNDARY
- HYDROLOGY SUB AREA BROUNDARY
- DIRECTION OF FLOW (STORM DRAIN)
- MODULAR BIORETENTION BMP (FLOW-THROUGH)
- BIORETENTION WITH UNDERDRAIN
- A3 / 0.66 — DRAINAGE AREA ID / ACREAGE
- 4 — BASIN NUMBER



DRAINAGE AREA	ACREAGE	IMPERVIOUS %	SWQDv * 1.5 (BIOFILTRATION)	SWQDf * 1.5 (BIOFILTRATION)	REQUIRED TREATMENT	PROPOSED TREATMENT	BMP TREATMENT PROVIDED
A	42.2	79%	165528	12.01	27025 SF Bioretention Surface Area OR 12.01 cfs	Modular Flow-through Bioretention	12.01 cfs
B	34.7	74%	129373	9.88	21122 SF Bioretention Surface Area OR 9.88 cfs	Modular Flow-through Bioretention 1 Bioretention with Underdrain 2 Bioretention with Underdrain 3 Bioretention with Underdrain	2.86 cfs 5,000 ft^2 Bioretention Surface Area 5,000 ft^2 Bioretention Surface Area 5,000 ft^2 Bioretention Surface Area

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Scale: 1" = 300'

Exhibit Date: 3/21/2013

CONCEPTUAL LID BMP EXHIBIT ALT #2 BROOKFIELD - LINCOLN WHITTIER, CA

APPENDIX H

Existing State off site 36" RCP

36" RCP
L = 1300 lf
Downstream inv = 150.92
Upstream inv =168.79 S_{avg} = 0.0137

Q	S_f	Length	Head Loss	Soffit Control Downstream	HGL at project	Ground Elev at Project	Comment
85	0.01624	1300	21.12	153.92	175.04	184	OK
95	0.02029	1300	26.38	153.92	180.30	184	OK - Max Capacity
110	0.02721	1300	35.37	153.92	189.29	184	High
140	0.04407	1300	57.29	153.92	211.21	184	High
172	0.06652	1300	86.47	153.92	240.39	184	High

LEGEND:

- NELLES PROJECT SITE BOUNDARY
- MUNICIPAL BOUNDARY
- EXIST. STATE OF CALIF. STORM DRAIN
- EXISTING L.A.C.F.C.D. STORM DRAIN

N

100' 0' 5 100' 200'

SCALE: 1" = 100'

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N

Scale: 1" = 100'

Exhibit Date: 3/21/2013

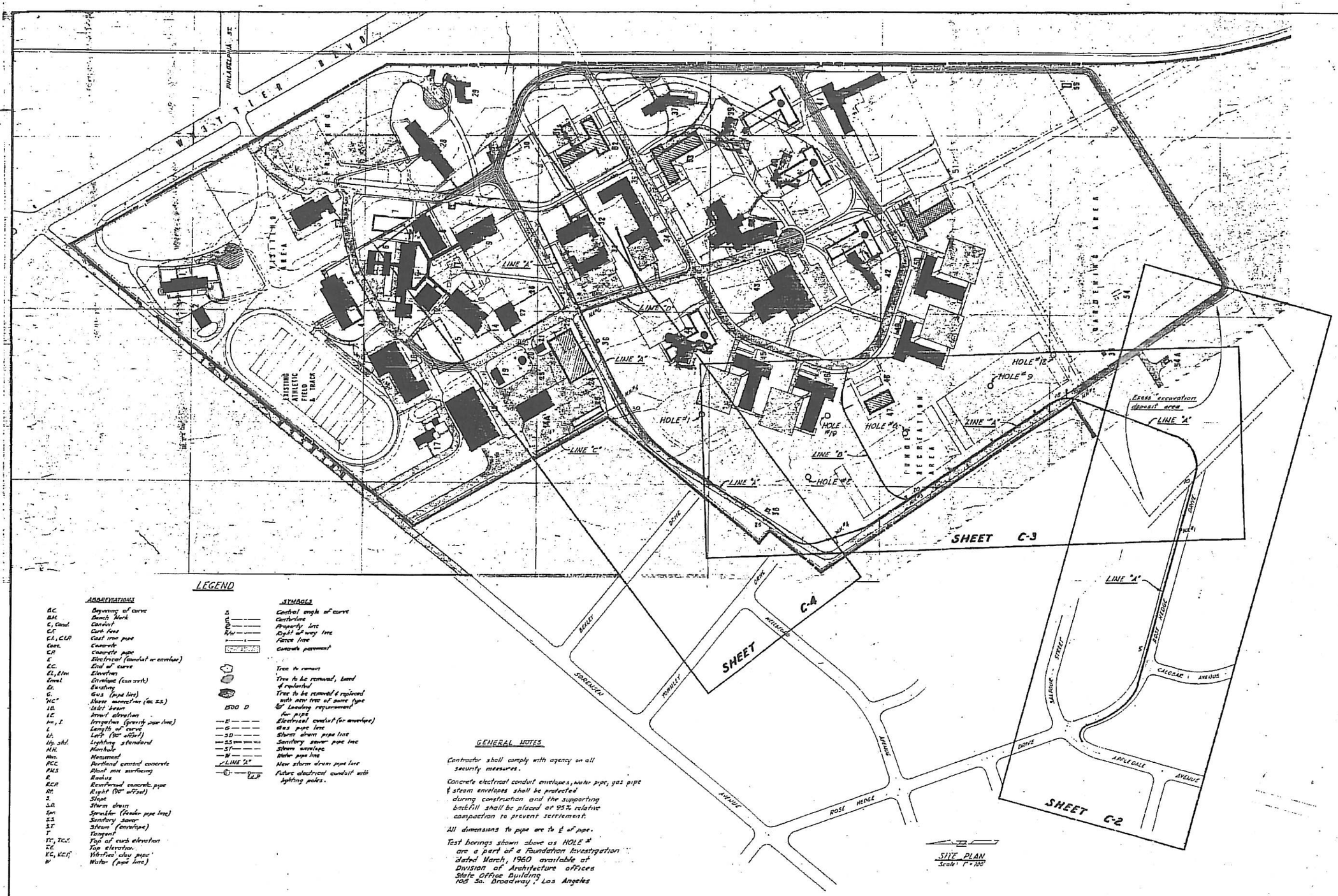
EXISTING OFFSITE STORM DRAIN EXHIBIT FRED C. NELLES SITE WHITTIER, CA

P:\PROJECTS\308'50\ENG\EXHIBITS\HYDROLOGY\30850-XH-EXISTING OFFSITE SD.DWG (08-14-13 3:37:59PM) Plotted by: Gordon Chon

Google earth

miles 700

km 1000



LEGEND

ABBREVIATIONS

B.C.	Beginning of curve
B.M.	Bench Mark
C, Cond.	Conduit
C.F.	Curb face
C.I., C.I.P.	Cast iron pipe
Conc.	Concrete
C.P.	Concrete pipe
E	Electrical (conduit or envelope)
E.C.	End of curve
El., Elev.	Elevation
Envel	Envelope (con'crete)
Ex.	Excavating
G.	Gas (pipe line)
"HC"	Heavy connection (ac. ss.)
I.B.	Light beam
I.E.	Invert elevation
Irr., I.	Irrigation (gravity pipe line)
L	Length of curve
Lt.	Left (90° offset)
Ltg. std.	Lighting standard
M.H.	Manhole
Mon.	Monument
PCC	Portland cement concrete
PMS	Plant mix surfacing
R	Radius
RCP	Reinforced concrete pipe
Rt.	Right (90° offset)
S.	Slope
S.D.	Storm drain
Spr.	Sprinkler (feeder pipe line)
S.S.	Sanitary sewer
ST	Steam (envelope)
T	Tangent
TF, T.O.F.	Top of curb elevation
T.E.	Top elevation
VC, V.C.P.	Vitrified clay pipe
W	Water (pipe line)

SYMBOLS

Δ	Central angle of curve
℄	Centerline
⊕	Property line
R/W	Right of way line
×	Fence line
	Concrete pavement
	Tree to remain
	Tree to be removed, based & replanted
	Tree to be removed & replaced with new tree of same type
1500 D	6" Leaching requirement for pipe
E	Electrical conduit (or envelope)
G	Gas pipe line
SD	Storm drain pipe line
S.S.	Sanitary sewer pipe line
ST	Steam envelope
W	Water pipe line
LINE "A"	New storm drain pipe line
E L.P.	Future electrical conduit with lighting poles.

GENERAL NOTES

Contractor shall comply with agency on all security measures.

Concrete electrical conduit envelopes, water pipe, gas pipe & steam envelopes shall be protected during construction and the supporting backfill shall be placed at 95% relative compaction to prevent settlement.

All dimensions to pipe are to ℄ of pipe.

Test borings shown above as HOLE # are a part of a Foundation Investigation dated March, 1960 available at Division of Architecture offices State Office Building 108 So. Broadway, Los Angeles

SITE PLAN
Scale: 1" = 100'

MICROFILMED
AS BUILT

THIS DRAWING IS HEREBY ACKNOWLEDGED TO BE PART OF THE PLANS REFERRED TO IN MY CONTRACT WITH THE STATE DEPARTMENT OF PUBLIC WORKS, DIVISION OF ARCHITECTURE.

DATE [redacted]

CONTRACTOR [redacted]

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ARCHITECTURE
LOS ANGELES

BY [signature] DEPUTY CHIEF, ARCHITECTURE AND ENGINEERING

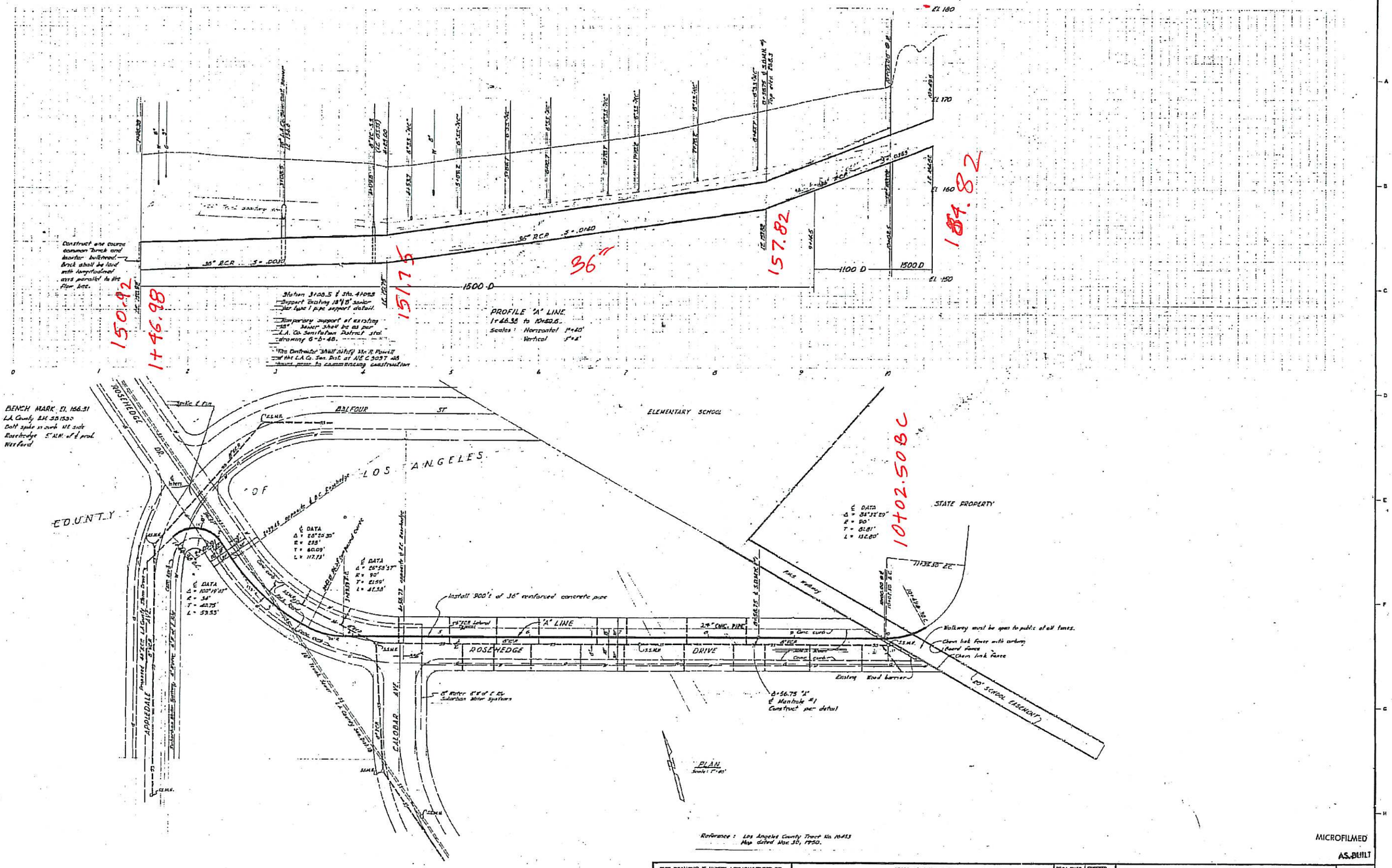
PROJ. ENGR. L.A. Lawrence	CHECKED H. Lewis	SHEET TITLE	SITE PLAN
DESIGNER K. Hill	DATE 3-30-62	PROJECT	STORM DRAIN SYSTEM - PHASE I
DRAWN K. Hill	W.O. 4-201-01	INSTITUTION	EC NELLES SCHOOL FOR BOYS
TRACED	CALIFORNIA	LOCATION	WHITTIER

SHEET C-1 OF 5

FILE 30-C-8

References: A.F. 043, 045, 056, 110, 087, 014
F.B. 257, 204

C.1-C.5



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TIES DRAWING IS HEREBY ACKNOWLEDGED TO BE PART OF THE PLANS REFERRED TO IN MY CONTRACT WITH THE STATE DEPARTMENT OF PUBLIC WORKS, DIVISION OF ARCHITECTURE.

DATE [redacted]

CONTRACTOR [redacted]

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ARCHITECTURE
LOS ANGELES

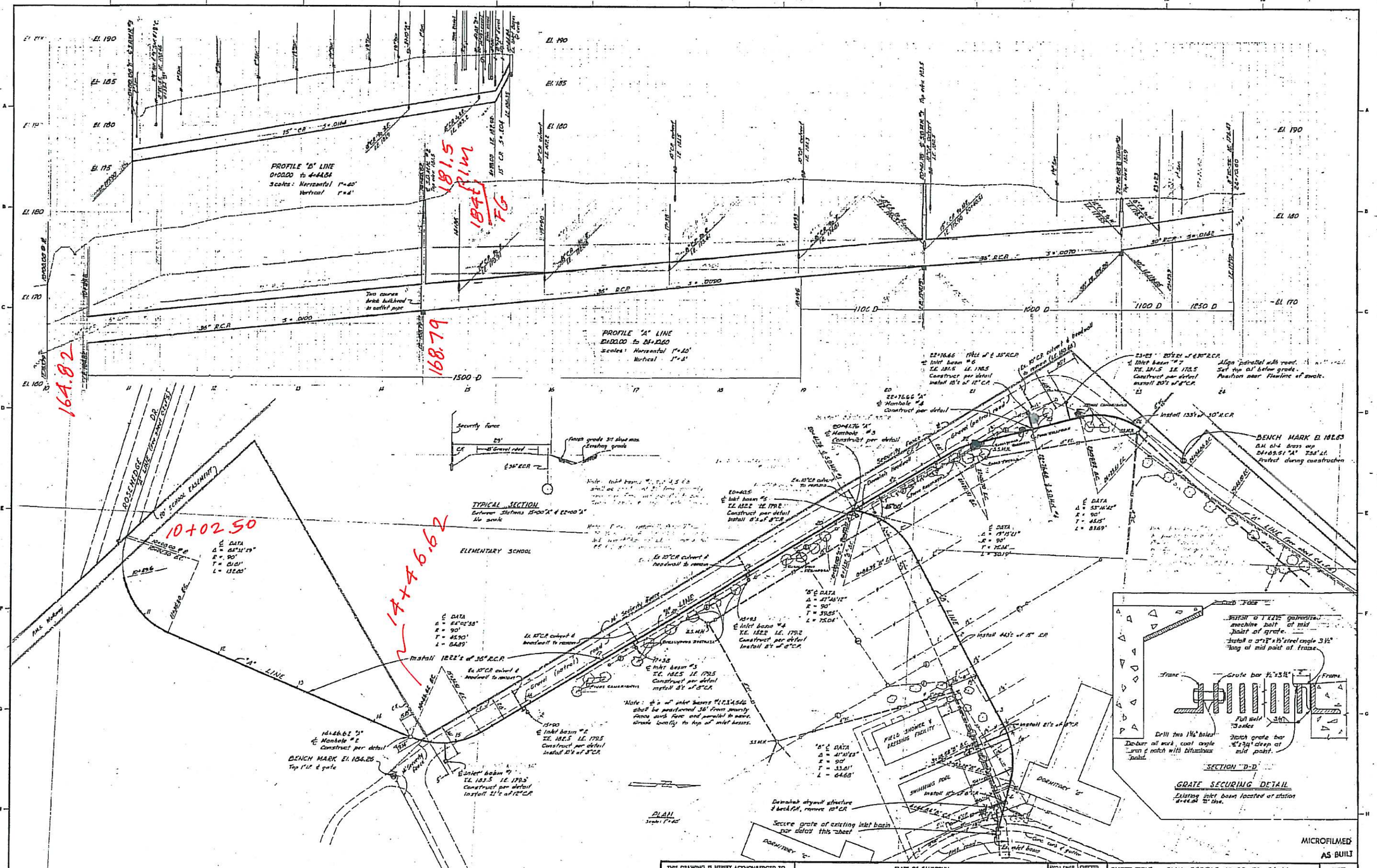
BY [signature] DEPUTY CHIEF, ARCHITECTURE AND ENGINEERING

PROJ. ENGR. J.A. Jamison	CHECKED D. Lewis	SHEET TITLE	PLAN - PROFILE 1+46 TO 10+50
DESIGNED H. Hill	DATE 9-20-62	PROJECT	STORM DRAIN SYSTEM - PHASE I
DRAWN H. Hill	W.O. 4F03 012C	INSTITUTION	FC WELLES SCHOOL FOR BOYS
TRACED [redacted]	CHIEF ENGINEER [redacted]	LOCATION	WHITTIER

SHEET C-2 OF 5

FILE 30-C-2

28 X 42


PROFILE "B" LINE
0+00.00 to 4+44.84
Scales: Horizontal 1"=40'
Vertical 1"=4'
PROFILE "A" LINE
22+00.00 to 26+21.60
Scales: Horizontal 1"=20'
Vertical 1"=4'
TYPICAL SECTION
ELEMENTARY SCHOOL
PLAN
Scale: 1"=40'
BENCH MARK El. 186.26
BENCH MARK El. 181.63
SECTION "D-D"
GRATE SECURING DETAIL
Secure grate of existing inlet basin not detail this sheet
MICROFILMED
AS BUILT
THIS DRAWING IS HEREBY ACKNOWLEDGED TO BE PART OF THE PLANS REFERRED TO IN MY CONTRACT WITH THE STATE DEPARTMENT OF PUBLIC WORKS, DIVISION OF ARCHITECTURE.
DATE
CONTRACTOR
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ARCHITECTURE
LOS ANGELES
SHEET TITLE PLAN - PROFILE 10+50 TO 26+21
PROJECT STORM DRAIN SYSTEM - PHASE I
INSTITUTION FC HELLES SCHOOL FOR BOYS
LOCATION WHITTIER.
SHEET C-3 OF 5
28 X 42

APPENDIX I

FUSCOE
ENGINEERING

Memo

To: File

From: Puneet Comar, P.E./ John Olivier, P.E.

Date: March 17, 2014

Re: Lincoln – Commercial Site drainage alternative

The purpose of this memo is to provide the results of analyzing the impacts of removing the 14.6 acre commercial site from the drainage study, assuming the commercial site will be responsible for its own onsite detention and water quality facilities.

As stated in the preliminary drainage report, the capacity of the existing 36" RCP at the southerly portion of the site is approximately 85 CFS.

In the proposed conditions, Area A, which is upstream of the proposed detention system consist of 42.2 acres with an impervious ratio of approximately 79%. Utilizing the TC Calculator, the flow rate emanating from Area A for a 50 year storm event is approximately 65 cfs. These flows are detained in the proposed detention system before combining with Area B, which is downstream of the detention system and generates storm flow runoff of approximately 58 cfs. An approximate 12 ac.ft dual system detention basin is proposed to mitigate for water quality treatment and peak flow detention in order to meet the capacity of the existing 36 RCP as described above.

Removing the commercial portion (Subarea A1) from Area A creates a decrease in flow rate. With a 14.6 acre reduction in area and a net 7% reduction in imperviousness, Area A's flow rate is reduced from approximately 65 cfs to 46 cfs after removing the commercial area. This decrease in flow allows for a significantly smaller design for the detention basin. Using TC calculator to perform a hydrograph analyses and Hydraulic Toolbox to route the hydrograph though a detention system, it has been determined that a significantly smaller basin of approximately 3.5 ac.ft will be adequate to mitigate for water quality treatment and peak flow detention when the commercial site is removed, in order to meet the capacity of the existing 36 RCP.

Please refer to the following table, TC Calculator Results, and the provided Hydraulic Toolbox report for reference.

	With Commercial Area	Without Commercial Area
Acreage	42.2 ac	27.6 ac
LID volume	2.53 ac.ft	1.54 ac.ft
50 yr Flow	64.24 cfs	46.05 cfs
Flow Length	2,933 ft	2,089 ft
Impervious %	79	72
Basin Size	250x210x10	150x100x10
Volume (CF)	525,000 cf	150,000 cf
Volume (ac-ft)	12.05 ac-ft	3.44 ac-ft

It is important to note that the commercial site will discharge a storm flow rate equivalent to its existing condition flow rate. Therefore, though the commercial site will mitigates its increase in runoff, the residential area should assume it will still accept some flows equivalent to the existing condition. Accounting for this additional flow, a **detention basin of 6 ac.ft is recommended if the commercial site is removed from the study.**