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PROJECT SUMMARY INFORMATION

1.	**Project Title:**	City of Berkeley Watershed Management Plan (WMP)
2.	**Lead Agency:**	Department of Public Works City of Berkeley 1947 Center Street, 4th Floor Berkeley, CA 94704
3.	**Contact Person:**	Jennifer Duffield AMEC Environment & Infrastructure 2101 Webster Street, 12th Floor Oakland, California 94612 Direct Questions to: Daniel.Gira@amec.com; 805 962-0992 x 225
4.	**Project Location:**	The Watershed Management Plan Area (WMP Area) includes the area within the City of Berkeley's jurisdictional boundaries (Attachment 1).
5.	**Project Sponsor:**	City of Berkeley 2180 Milvia Street Berkeley, CA 94704
6.	**General Plan Designation:**	The WMP Area includes various General Plan designations.
7.	**Zoning:**	The WMP Area includes various zones.

8. Description of Project:

The Watershed Management Plan (WMP) is an integrated and sustainable strategy for managing urban water resources. It is intended to guide City efforts to establish a healthier balance between the urban environment and natural ecosystems. The WMP looks at addressing water quality, flooding, and the preservation of creeks and aquatic habitats using multi-objective approaches where possible. This entails supplementing the existing engineered storm drain infrastructure with green infrastructure approaches that mimic natural hydrologic processes, including filtration and infiltration by soils and evapotranspiration by plants. Additionally, various green retrofit measures appropriate for the public right-of-way as well as for public and private property are recommended in the WMP. These approaches also provide opportunities for the collection and non-potable re-use of stormwater. The WMP builds upon existing City practices by recommending policies and programs to meet various goals including:

- Water quality protection;
- Urban flooding reduction;
- Natural waterways and habitat protection; and,
- Rainwater re-use promotion.

The WMP is available online on the City's website at: www.cityofberkeley.info/WatershedPlan.

The following list summarizes the various ways the plan guides City activities to meet WMP goals:

- Identifies potential City programs for development;
- Identifies a suite of Capital Improvement Projects (CIP) for two watersheds (i.e., Potter Watershed and Codornices Watershed) as funding becomes available;
- Identifies areas for additional data collection and provides future recommendations; and,
- Identifies relevant City policies and refinements to City policy development.

The WMP's program and policy recommendations would need additional refinements before being fully developed and implemented. In this sense, the WMP provides direction to City staff for interdepartmental coordination and stakeholder outreach. CIP recommendations are provided on a watershed scale with site-specific conceptual designs. However, construction drawings and specifications still need to be prepared. The WMP has a suite of investigative recommendations for future WMP refinements.

In addition to providing recommendations, the WMP provides an overview of the watershed planning process, regulatory issues, and the WMP's relationship to existing City plans, policies, and programs. It further describes on-going City activities related to water quality, creeks, storm drain pipe infrastructure, and maintenance. The WMP concludes by providing four potential funding level proposals corresponding to various levels of WMP implementation.

Background

The development of a WMP was a key recommendation of the Creek Task Force, which was appointed by the City Council in 2006 to review and suggest improvements to the City's creek protection ordinance. Development of the WMP began in late 2008. The WMP's goals and objectives are consistent with the City of Berkeley (Berkeley) General Plan, and are specifically supported by Objectives 23-33 of the Environmental Management Element (beginning with "Water Quality in Creeks and San Francisco Bay"). These objectives and all others in the General Plan were evaluated in the City of Berkeley Draft General Plan Final EIR, certified in July 2001. The WMP is consistent with current regulatory requirements, while also recommending programs in anticipation of future regulatory mandates.

Berkeley is a densely developed city, comprised of 11 watersheds wholly or partially within City limits. All watersheds in Berkeley eventually drain to the San Francisco Bay, which is an important economic resource as well as an internationally recognized natural resource. Each watershed is unique with various mixtures of: land uses, demographic communities, and remaining aquatic and terrestrial wildlife habitats. For a detailed description of the watershed that would be affected under the WMP, refer to the "Surrounding Land Uses and Setting" section below.

Summary recommendations, Berkeley Watershed Mgmt. Plan, from 2012 Initial Study (of environmental impacts)

Regional Setting and Project Location Map

FIGURE 1

Watershed drainage pathways in Berkeley include curb and gutters and storm drain pipeline infrastructure as well as open and culverted creeks. The existing storm drain pipes and creek culverts on public property are 80 to 100 years old, and have exceeded their design life expectancies. As urban runoff travels over impervious surfaces, it can pick up various pollutants and gain volume and velocity, contributing to water quality impairments, localized flooding, and wash-out of in-stream habitat.

A key strategy of the WMP is the use of landscaping features and/or temporary storage devices to cleanse, reduce, and slow stormwater runoff. This approach is known as Low Impact Development (LID), which includes the use of bio-retention cells, vegetated swales, rainwater harvesting, and permeable paving. These practices (appropriate for both public and private property) can be combined and customized to fit the physical needs of a neighborhood. The WMP uses the term Green Infrastructure (GI) to describe LID measures in the public right-of-way or in open space areas.

Hydraulic modeling results indicate that when GI measures are combined with other traditional approaches, a number of WMP goals can be met for a capital cost similar to upsizing storm drain pipe diameters to convey more flow. The WMP has developed a Sustainable Green Infrastructure Capital Improvement Program (CIP) for the both the Potter and Codornices Watersheds, which represent the full drainage spectrum within the City.

Another important component in the WMP is a rehabilitation program for existing storm drain infrastructure that is deteriorating as it ages. A similar program is recommended for creek culverts in the City right-of-way. Although these rehabilitation programs by themselves would be considered maintenance operations that are categorically exempt from CEQA, because they are part of the overall WMP, their impacts are included in this analysis.

WMP Recommendations

The WMP provides recommendations for a variety of programs and policies for further consideration and exploration by affected City departments, key stakeholders, and the City Council. Key WMP recommendations are provided below with each recommendation’s corresponding number in parenthesis.

A. Recommendations requiring consideration and coordination among City Departments include:
   - Seek LID/GI Coordination Opportunities with existing Public Works Programs (3.2)
   - Develop “In-Lieu” Pilot Program for LID (3.4)
   - Promote Private Property LID (4.5)
   - Evaluate and Explore Street Sweeping Efficiency Improvements (7.12)

B. Recommendations requiring stakeholder coordination and agreements include:
   - Develop and Implement Volunteer Creek Assessment Pilot Program – need permission from property owners (5.7)
   - Increase Stormwater Conveyance Capacity though HWY I80/580 corridor to the Bay – need agreements with the California Department of Transportation (Caltrans) (8.1 & 8.2)
   - Realign Pipes and Install Trash Removal Device in Potter Stormdrain Trunkline – need permission from Union Pacific Railroad (UPRR) (8.1)

- Continue Creek Restoration Partnerships and Establish Operational Guidelines for Village Creek By-Pass – City of Albany and University of California (5.6 & 8.2)
- Identify and Pursue Partnerships Opportunities to Develop Mutually Beneficial Projects – potentially with the Berkeley Unified School District and the University of California (1.5)

C. Recommendations for Public Outreach and Participation

- Conduct on-going inter-departmental coordination (1.1)
- Conduct public meetings and make presentations to public commissions and City Council (1.2)
- Routinely update Watershed Resource webpage (1.3)
- Conduct watershed-specific public meetings (1.4 & 1.6)

D. Recommendations for Capital Improvement Programs in Codornices and Potter Watersheds

<u>Codornices Watershed (8.2)</u>

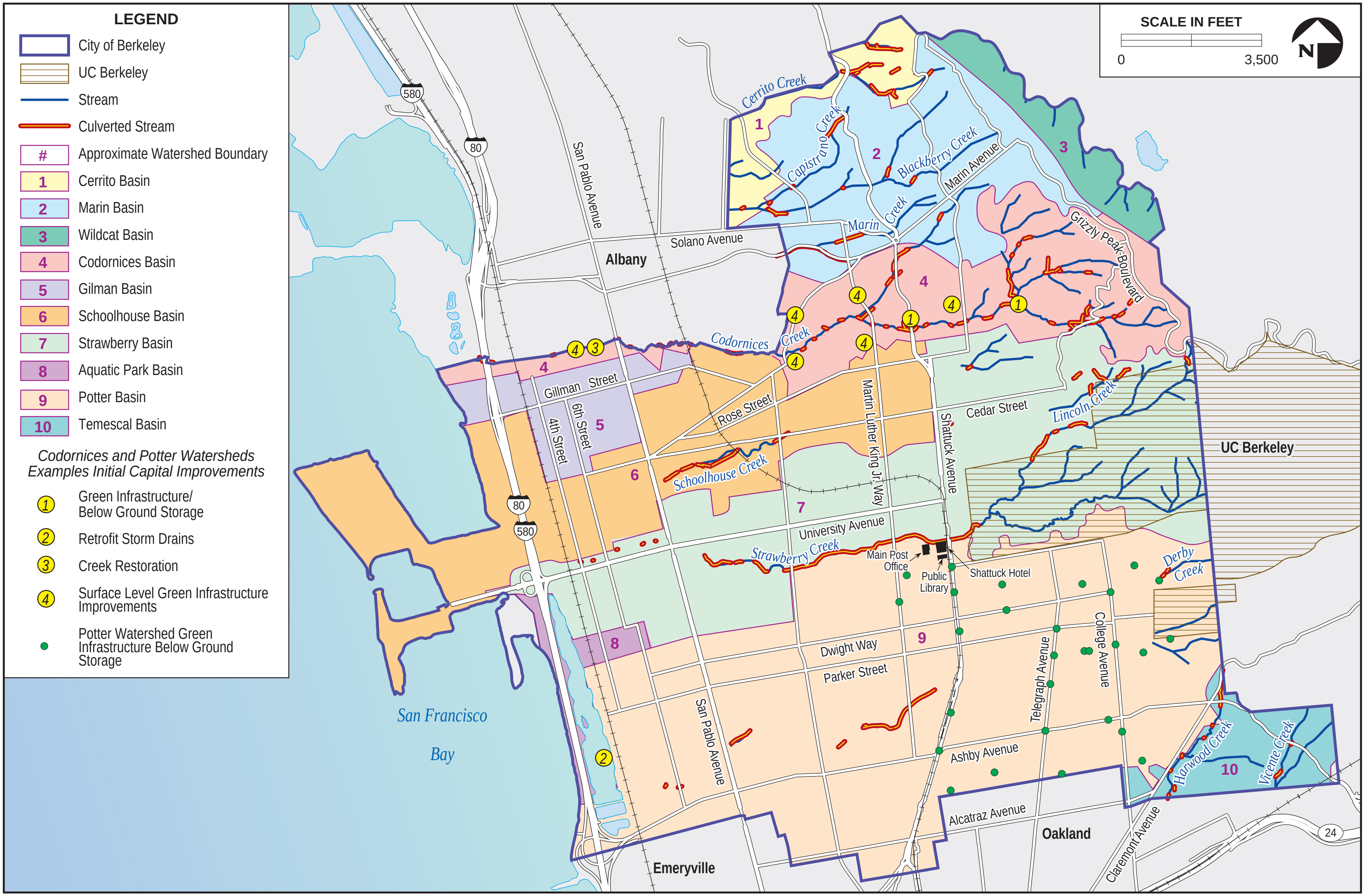
1. GI/Storage below basketball courts at Codornices Park
2. GI Continuous Deflective Separation (CDS) units at stormdrain outfalls into watercourse
3. GI/Storage (with new Eunice Street storm drain pipeline) at Henry Street (includes bio-retention cells on Eunice and Henry)
4. Berm at Second Street
5. Creek Restoration from San Pablo to Tenth Street
6. Storm Drain Pipe Retrofit on Shasta branch
7. Storm Drain Pipe Retrofit on Cragmont-Euclid branch
8. Creek Restoration from railroad to Eastshore Hwy Rd
9. GI (Bio-retention and Permeable paving) at opportunity sites in commercial areas
10. Creek Restoration Tenth Street to Eighth Street

<u>Potter Watershed (8.1)</u>

1. Retrofit Lower Trunkline (railroad to San Francisco Bay outfall) with 8-9' diameter pressure pipe, with trash rack in diversion box (by railroad tracks)
2. GI/Storage east of Shattuck (53 Units)
3. Retrofit Trunkline from railroad to San Pablo Ave
4. Retrofit Trunkline from San Pablo Ave to MLK/Adeline/Shattuck
5. Transite line removal, new lines parallel with railroad
6. Retrofit specific storm drain lines

E. Recommendations for Areas of Further Information and Study

- Creek Culvert Condition Assessment Program (5.4)
- Storm Drain Infrastructure Condition Assessment Program (6.3)
- Hydraulic Modeling of Remaining Watersheds (Strawberry, Schoolhouse, Gilman, Marin, Cerrito, Wildcat, and Temescal) (6.2)



City of Berkeley Watersheds and Representative Capital Improvements

FIGURE 2

9. Surrounding Land Uses and Setting:

The WMP Area spans the entire area, approximately 10.5 square miles, within the jurisdiction of the Berkeley. Berkeley is located in northern Alameda County on the eastern shoreline of the San Francisco Bay and extends east to the ridgelines of the East Bay Hills. The City is bordered to the north by the City of Albany, to the east by the East Bay Regional Park District's Tilden Park and the City of Oakland, to the south by the City of Oakland and the City of Emeryville, and to the west by the San Francisco Bay. Berkeley is a densely developed urban area, with a variety of land uses, including high, medium, and low density residential; commercial; industrial; institutional; recreational; open space; and streets and sidewalks (General Plan, 2002).

In general, the physiography of the Berkeley watersheds reflects their general position or alignment in relation to the primary geologic structures in the East Bay. The watersheds in Berkeley typically drain to the west out of the steeper headwaters (Berkeley Hills, with a maximum elevation of approximately 1,770 feet above mean sea level at Chaparral Peak), across a transitional alluvial fan zone, and then across the more gently sloping Bay plain before discharging into the San Francisco Bay (located approximately at sea-level). One exception to this trend is the Wildcat watershed, which runs north-south on the eastern side of the ridgelines of the Berkeley Hills. While Berkeley is predominately urban, a drainage from approximately 2 square miles of non-urban area outside the City boundary also flows into the City from Strawberry Canyon and Claremont Canyon east of the City.

Like most of Northern California, climate of the Berkeley area is largely governed by weather patterns originating in the Pacific Ocean, in winter most notably by the southern descent of the Polar Jet Stream bringing with it mid-latitude cyclonic storms. Climatic conditions in Berkeley are generally characterized as Mediterranean with moist, mild winters and hot, dry summers. Consequently, more than 90 percent of precipitation falls between November and April, with an annual rainfall amount of about 18-26 inches depending on location (microclimate effects).

Excluding Marina watershed, there are 11 watersheds wholly or partially within the City of Berkeley. Several of these watersheds extend past Berkeley's municipal boundaries where the City borders on the Town of Emeryville and the City of Oakland to the south. Additionally, many of these watersheds also extend into the Cities of Albany and El Cerrito to the north.

Watershed	Area within the City (acres)
Wildcat	152
Cerrito	149
Marin	699
Codornices	570
Gilman	249
Schoolhouse	703
Strawberry	1,385
Aquatic Park	134
Potter	2,053
Temescal	205

At the initiation of the WMP process, the City allocated funding to develop hydraulic models for two watersheds. The Potter and Codornices Watershed were selected because they represent the full range of the urban drainage spectrum in Berkeley.

The Potter Watershed, which is the southernmost watershed within the City, drains approximately 30 percent of Berkeley's land area through storm drain pipe infrastructure. This is the largest watershed in the City and experiences localized flooding in many areas. Additionally, it contributes runoff to the Aquatic Park Lagoon, which is a public park located just to the east of the Eastshore Freeway. The lagoon still connects with the San Francisco Bay through culverts under the freeway. Potter Creek itself is adjacent to a significant amount of protected land including a 72-acre parcel of forest wetlands and salt marsh continuing across Bayview Avenue to Barnegat Bay, which the Trust for Public Land conserved and transferred to Berkeley Township in 1997.

The Codornices Watershed drains approximately 10 percent of the City through open winding watercourses and creek culverts. This watershed is regionally significant as Codornices Creek is one of the least culverted creeks in the East Bay. Additionally, it is one of the few creeks in the East Bay with a salmonid fishery population. Codornices Creek is one of the most publicly accessible creeks in Berkeley, along with Strawberry Creek,as it runs through a number of public parks. Additionally, Codornices Creek has been the subject of a number of local creek restoration projects, including an effort to restore the creek between the railroad tracks and 9th Street.

Watershed Characteristics	Codornices Watershed	Potter Watershed
Drainage Area Total (acres)	796	2,693
Annual Precipitation (inches)	24	22
Estimated Impervious Surface (%)	34	55
Average Annual Wet Season Runoff (acre feet)	596	2460
Estimated Open Channel Length (feet)	15,477	2,254
Estimated Culvert Length (feet)	11,435	3,037
Estimated Storm Drain Pipe Length (feet)	40,088	187,020

Note: For descriptions of remaining watersheds in the City of Berkeley, please refer to Page 13 within the City of Berkeley Watershed Management Plan.

10. Other Public Agencies Whose Approval is Required:

No other public agency approvals are needed for this planning stage. However, for WMP implementation, individual projects are likely to need other public agency approvals depending on the project location and scope. These agencies may include:

- San Francisco Bay Regional Water Quality Control Board (SFBRWQCB)
- California Department of Fish & Game (DFG)
- Bay Conservation and Development Commission (BCDC)
- California Department of Transportation (Caltrans)
- Union Pacific Railroad Company (UPRR)
- University of California, Berkeley (UCB)
- Berkeley Unified School District (BUSD)
- City of Albany (Albany)
- City of Oakland (Oakland)
- City of Emeryville (Emeryville)

CHAPTER 8: CODORNICES & POTTER WATERSHEDS HYDRAULIC MODELING FINDINGS

STRATEGY

At the initiation of the WMP process, the City allocated funding to develop hydraulic models for two watersheds. The Potter and Codornices Watersheds were selected because they represent the full range of the urban drainage spectrum in Berkeley. The Potter Watershed drains approximately 1/3 of the land area of the City through storm drain pipe infrastructure. The Codornices Watershed drains about 1/10 of the City through open watercourses and creek culverts.

Findings from these two watersheds could be extrapolated to the other watersheds, but it is preferable to continue hydraulic modeling of the remaining watersheds.

The Potter watershed is the largest in the City; it experiences localized flooding in many areas; and it contributes runoff to the Aquatic Park Lagoons. The Codornices Watershed is regionally significant as Codornices Creek is one of the least culverted creeks in the East Bay; and is one of the few with a salmonid population.

Balance Hydrologics, Inc. (Balance), a local water engineering firm, was retained to develop the two hydraulic models. The scope of work[9] included developing baseline (existing watershed conditions) hydraulic and hydrologic models to determine expected runoff volumes and quantify the existing conveyance capacity of storm drain infrastructure and other drainage pathways (watercourses and creek culverts). Various potential retrofit scenarios were then input to the models to quantify the expected flood reduction benefits of these approaches. Retrofit scenarios in the scope of work included examination of: 1) stormwater storage BMPs (rainbarrels, cisterns, permeable pavements with subsurface gravel reservoir storage), 2) biofiltration BMPs (flow through planter boxes, rain gardens, and swales), 3) combined stormwater storage BMPs and biofiltration BMPs, and 4) retrofits to storm drain pipes (diversion pipes, enlargement, and pumps). Balance also developed cost estimates for the design, permitting, and construction of the various scenarios.

[9] Balance modeling was limited to incorporating pipe sizes of 18” in diameter or greater.

POTTER WATERSHED FINDINGS

Potter Drainage Pathways

The storm drain pipe infrastructure consists of a main trunkline and a network of branches and laterals. The trunkline runs from the intersection of Adeline/Woolsey and MLK, Jr. Way to the Bay outfall.

Five branches feed into the trunk line from the north:

1. San Pablo Ave Branch
2. Russell-Mabel Branch
3. Sacramento Branch
4. Ellis-Grant Branch
5. Shattuck-Adeline-Ashby-MLK Branch

Three other branches east of Shattuck/Adeline feed either the trunk or lead into another branch:

1. Upper Woolsey Branch
2. Derby Branch
3. Parker-Dwight Branch

The remaining pipelines input into the model include lateral lines from the branches, as well as a network of storm drain pipelines west of San Pablo Ave and south of Dwight Way leading to Aquatic Park.

See Appendix C Maps: Potter Watershed Existing System Results (May 6, 2011).

Existing Conditions Results

From a 10-yr design storm, the Potter Watershed generates an estimated 236 acre feet (af)[10] of runoff. Most pipelines including the trunkline are operating at or above capacity for a 10-year storm with about 34 af of flooding predicted throughout the watershed (Table 8-1). Maximum capacity discharged to the Bay is 446 cubic feet per second (cfs).

Trunk/Branch	Total Flooding (af)	% of Total Flooding	Max. Discharge (cfs)
Main Trunk (outfall to Bay)	-	-	445.8
Main Trunk (overflow into MYB[11])	-	-	217.0
Main Trunk (inlet)	15.1	44.2%	403.8
San Pablo Branch	1.7	4.9%	73.1
Russell – Mabel Branch	0.0	0%	68.4
Sacramento Branch	0.0	0.1%	122.0
Ellis-Grant Branch	5.8	17%	120.4

[10] An acre foot equates to one square acre of water one foot deep.

[11] MYB: Model Yacht Basin, Aquatic Park

Trunk/Branch	Total Flooding (af)	% of Total Flooding	Max. Discharge (cfs)
Shattuck – Adeline – Ashby – MLK Branch	2.3	6.7%	317.6
Upper Woolsey Branch	4.0	11.8%	129.3
Derby Branch	2.8	8.1%	76.8
Parker - Dwight Branch	2.4	7.2%	154.4
TOTALS	**34.1**	**100.0%**	

Table 8-1

The modeling identified locations of predicted overflows. Many of these locations were confirmed as chronic nuisance flooding sites by PW Maintenance staff and correspond well with City experiences during the storms of February 25, 2004 and the El Nino events of the 2005-06 rainy season. Localized flooding can be expected in varying degrees within the locations in Table 8-2.

Street Name	Cross Streets
San Pablo Avenue	between Ward and Murray
California Street	between Woolsey and Harmon
Woolsey Street	between California and Adeline; at Dana
Ashby Avenue	between California and King
Martin Luther King, Jr. Way	between Russell and Woolsey
Parker Street	between Seventh and Fourth
Fulton Street	at Derby
Ellsworth Street	between Blake and Parker
Telegraph Avenue	between Ashby and Woolsey; at Stuart
College Avenue	at Dwight

Table 8-2

Tidal effects from the Bay compound the Potter Watershed flooding problems as far upland as Adeline/Woolsey. This is due to the water surface of the Bay effectively reducing the discharge ability of the storm drain trunk line. Thus 10-year frequency storms in combination with high tides will cause flooding in the Potter watershed.

Options Analyzed

To provide desired level of flood protection, the storm drain trunk line must handle the 25-year design storm runoff and all other branches and laterals must handle the 10-year design storm runoff with minimal flooding. There are several approaches the City considered to achieve these goals.

Traditional Pipe Upsizing

One consideration for improving pipe line capacity is the traditional approach of upsizing the entire network of pipes such that each pipe is sized and shaped to efficiently convey the appropriate design storm runoff. In this scenario, roughly 35,000 lineal feet of storm drain pipeline would be replaced with larger diameter pipes.

However, if all upstream pipes were upsized, then the main trunkline would need to be massively enlarged to accommodate the additional flow volumes. Most of the existing 9-foot diameter egg-shaped trunk would need to be replaced with a much larger box-shaped trunk, ranging from 7-feet x 20-feet (H x W) to 10-feet x 10-feet for an estimated cost of $33M.

The upsizing of the remaining branch pipelines would cost an estimated $19.75M. The total estimated cost of this approach (not including resolution of tidal effects, Aquatic Park pipeline replacement, or water quality protection measures) is $52.75M.

It should be noted that regardless of what overall approach the City takes to reduce flooding, a significant amount of pipe upsizing will be necessary, including the main trunk and at site specific locations where existing pipes constrict flow.

Resolution of SF Bay Tidal Effects

Six options were developed to resolve the tidal effects. All options are listed in Table 8-3 with their description and their pros and cons. The two options the City is considering are Option 1: discharges stormwater directly to SF Bay (preferred option); and Option 5: discharges most stormwater directly to SF Bay and only discharges to Aquatic Park Lagoon on high flow levels (no additional stormwater into Aquatic Park).

	Option	Description	Pros	Cons
1	**Pressure pipe outflow to Bay for entire Q10** Capacity to Bay = 1,400 cfs Flow to Aquatic Park = 0 cfs **$17,238,000**	1. Pressure pipe = single 11-ft diameter or twin 8-ft diameter; 1,525 ft total length 2. Rebuild existing outfall to Bay, add new outfall if twin pipe option is used 3. New large collector box with trash rack at upstream end	1. No stormwater flows from Potter Watershed to Aquatic Park. 2. Inclusion of trash rack would allow meeting trash TMDL for all Potter watershed.	1. Costly construction, including tunneling under I-80 and UPRR. 2. Lengthy permitting process of new outfall to Bay. 3. Very lengthy closure of I-80 on-ramp from Shellmound (~2 mos)
2	**Existing outfall plus storage in combined Radio Tower Pond and Model Yacht Basin** **N/A (infeasible)**	1. Maintain existing Potter trunk and outfall downstream of MYB 2. Construct diversion structure with trash rack and automated control gates to allow flow to MYB + ML only when excess storage needed 3. Increase trunk line size from above UPRR to new diversion structure	1. Potential major cost savings with reduced infrastructure 2. No new Bay outfall, much simpler permitting 3. Limited I-80 on-ramp closure	**1. Infeasible, not enough storage in RTP + MYB** 2. Stormwater still flows to Aquatic Park in large events

	Option	Description	Pros	Cons
3	**Pump station with no storage to supplement existing outfall** Capacity to Bay = 1,400 cfs Flow to Aquatic Park = 0 cfs **$39,000,000**	1. Construct pump station to handle flow that cannot be conveyed by existing outfall (latter left in place) 2. Construct new force main outfall to Bay for pump station outflow 3. Provide trash rack at pump for all flow	1. No stormwater flows from Potter to Aquatic Park. 2. Inclusion of trash rack would allow meeting trash TMDL for all Potter watershed.	1. Costly construction, including tunneling under I-80 and UPRR. 2. Lengthy permitting process of new outfall to Bay. 3. Lengthy closure of I-80 on-ramp from Shellmound (~2 mos) 4. Relative high ongoing O&M costs
4	**Existing outfall plus storage in MYB+Main Lagoon** Capacity to Bay = 400 cfs Flow to Aquatic Park = 1,000 cfs **$6,405,000**	1. Maintain existing Potter trunk and outfall downstream of MYB 2. Construct new diversion structure with trash rack and automated control gates to allow flow to MYB + Main Lagoon only when excess storage needed 3. Increase trunk line size from above UPRR to New diversion structure	1. Potential major cost savings with reduced infrastructure 2. No new Bay outfall, much simpler permitting 3. No stormwater flows to Aquatic Park for small events (e.g. < 2-year storm) 4. Inclusion of trash rack would allow meeting trash TMDL for all Potter watershed. 5. Limited I-80 on-ramp closure	1. Stormwater still flows to Aquatic Park in large events, possibly more storm water in largest events depending on upstream system upgrades 2. Tunneling required under UPRR.
5	**Smaller pressure pipe plus storage in Main Lagoon** Capacity to Bay = 1,000 cfs Flow to Aquatic Park = 400 cfs **$14,788,000**	1. Maintain existing Potter trunk and outfall downstream of end Potter 2. Construct new 9-ft diameter pressure pipe directly to Bay to handle all initial discharge 3. Construct new diversion structure with trash rack at end of Potter, only flows above pressure pipe capacity flow down existing trunk	1. Almost no stormwater flows of any kind from Potter to Aquatic Park, could be none with green infrastructure in upper watershed 2. Inclusion of trash rack would allow meeting trash TMDL for all Potter watershed 3. With minor modification could have stormwater only go to RTP, not Main Lagoon	1. Costly construction, including tunneling under I-80 and UPRR. 2. Lengthy permitting process of new outfall to Bay. 3. Very lengthy closure of I-80 on-ramp from Shellmound (~2 mos)

	Option	Description	Pros	Cons
6	**Smaller pressure pipe plus smaller pump station** Capacity to Bay = 1,400 cfs Flow to Aquatic Park = 0 cfs **$35,700,000**	1. Maintain existing Potter trunk and outfall downstream of end Potter 2. Construct new 8-ft diameter pressure pipe directly to Bay to handle all initial discharge 3. Construct pump station to handle any larger flows 4. Construct force main from pump station to Bay routed inside existing trunk line	1. No stormwater flows of any kind from Potter to Aquatic Park. 2. Inclusion of trash rack would allow meeting trash TMDL for all Potter watershed.	1. Costly construction, including tunneling under I-80 and UPRR. 2. Lengthy permitting process of new outfall to Bay. 3. Lengthy closure of I-80 on-ramp from Shellmound (~2 mos) 4. Relatively high O&M 5. Capacity gained with pump station offset in part by lost capacity in existing trunk due to routing of force main.

Table 8-3

With the exception of Option #6, each of the options includes a new trunk line junction near the UPRR right-of-way that would be designed to accept discharges from a realignment existing storm drainpipes that currently drain into the park from Heinz, Grayson, Carleton, and Parker Streets.

Option 1: Pressure pipe outflow to Bay for entire Q10 – $17.3M: This option includes 1,525-feet of either a single 11-foot diameter pipe or twin 8' diameter pipes, rebuilding the existing outfall to the Bay and potentially adding another (for the twin pipe option); and installing a collector box with a trash rack at the upstream end. No stormwater would be discharged to Aquatic Park.

Option 5: Smaller pressure pipe plus storage in Main Lagoon - $14.8M: This option includes the construction of a new diversion structure with a trash rack at the end of Potter St. and a new 9-foot diameter pressure pipe from the diversion structure to the Bay. The existing lower Potter trunk and outfalls to the MYB would remain. Pressure pipe capacity to the Bay would be approximately 1000cfs with excess flows diverted to the existing lower trunk. Excess flows diverted to Aquatic Park can be further reduced by the installation of storage unit in the upper watershed.

Green Infrastructure

Green Infrastructure options were input into the model to determine the viability of reducing hydraulic loading to the storm drain pipe infrastructure using bio-retention measures and large volume storage units. The concept is to strategically locate surface-level bio-retention measures (rain gardens and swales) within the planter strip area of sidewalks, within red zone curb-extensions, and in street medians as feasible. Permeable paving can be used in sidewalk areas, parking lanes, and residential streets where site conditions limit the area available for bio-retention. These GI features would drain into large underground storage pipes, which would fill during storm events and discharge metered flows into the existing storm drain pipelines through small orifices (Figures 8-1 and 8-2, Green Street Cross-Section & Plan View).

The assumed storage unit was represented in the model as a 6-feet diameter by 300-feet long pipe. Any configuration of GI and underground storage would need to approximate this volume to realize the level of flow-reduction benefits predicted by the modeling.

Modeling results indicate that the GI approach is much more effective in locations east of Adeline/Shattuck, and there are diminishing returns on investment beyond 54 units. However, 54 GI/Storage units in the upper watershed would result in incremental flood reductions throughout the watershed.

This cost estimate factors in site preparation, street demolition and disposal, materials and installation of the GI unit, and street replacement. Total estimated cost for 54 units is $31.3M.

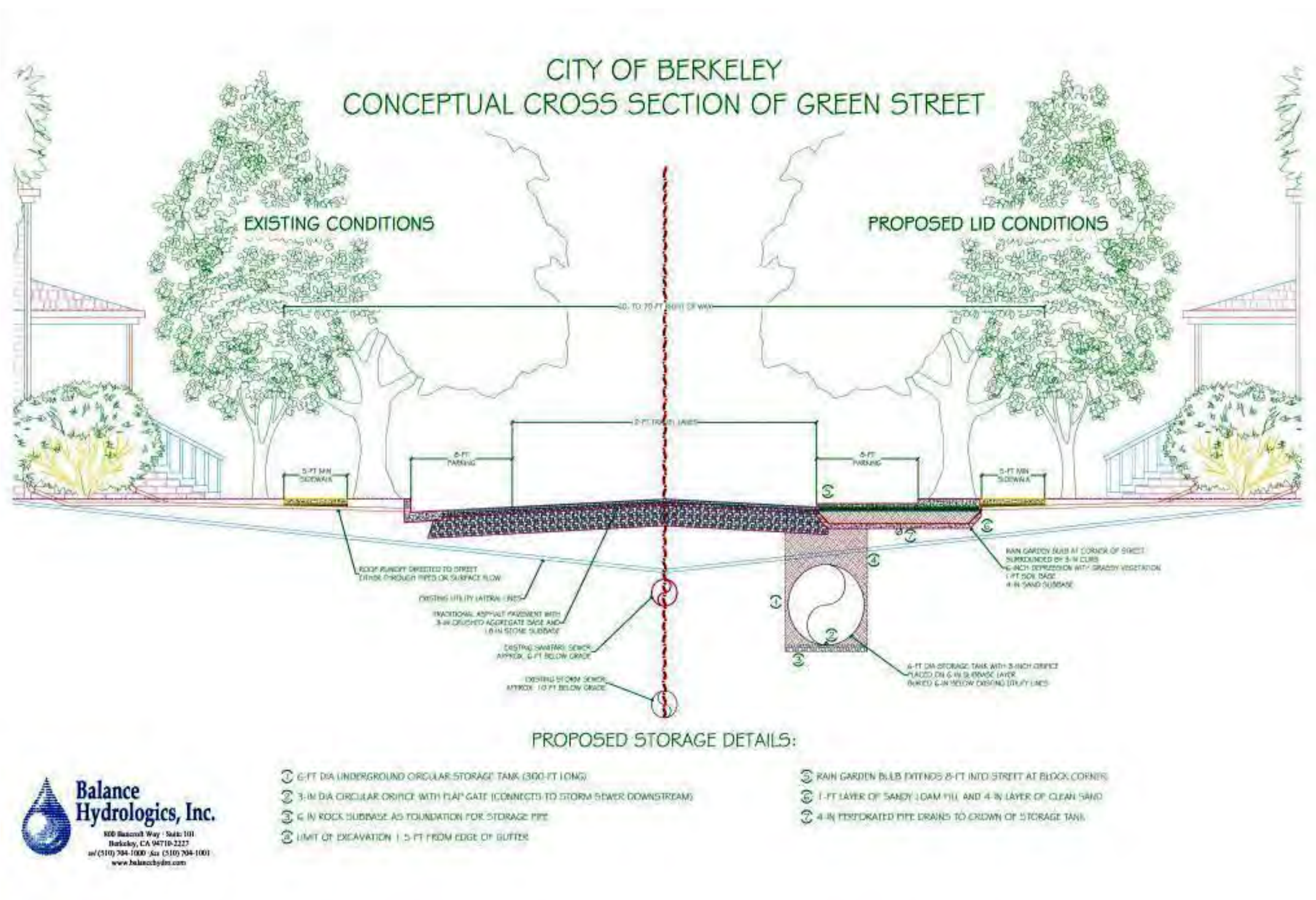


Figure 8-1, Conceptual Cross Section of Typical Green Infrastructure

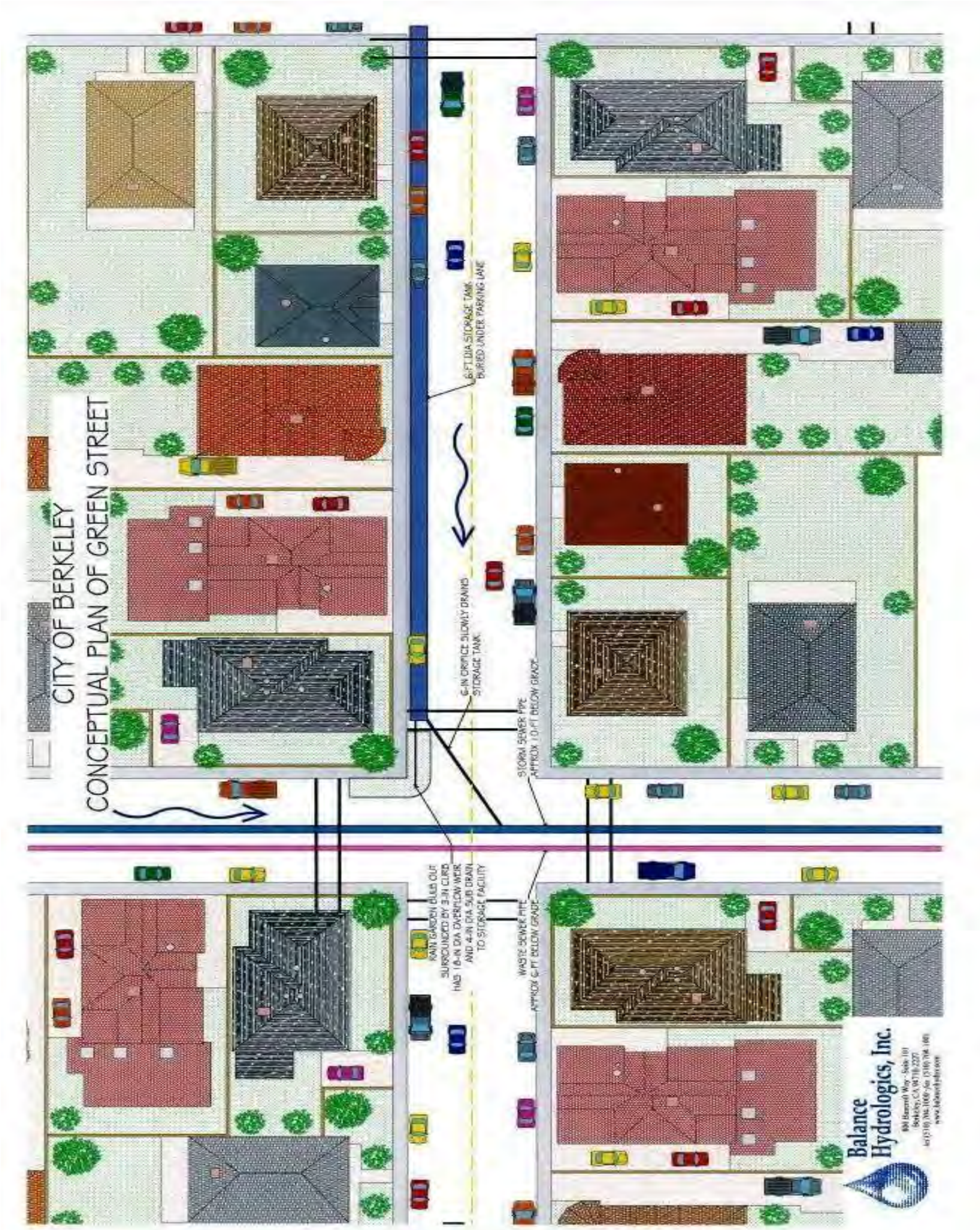


Figure 8-2, Conceptual Plan View of Typical Green Infrastructure