UPPER GALLINAS CREEK RESTORATION OPPORTUNITIES

12/7/2016

Gallinas Watershed Program

Investigating opportunities to restore the concrete channel in Terra Linda to a natural channel

FINAL

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Upper Gallinas Creek Restoration Opportunities

GALLINAS WATERSHED PROGRAM

ONE | INTRODUCTION

Gallinas Creek flows though the San Rafael neighborhood of Terra Linda and the unincorporated community of Santa Venetia before entering San Pablo Bay (Figure 1). The watershed drains 5.6 square miles between the Terra Linda/Sleepy Hollow Open Space Preserve and the San Pablo Bay. Upper Gallinas Creek (north fork) was channelized into a concrete trapezoidal structure in the 1950s. The structure is nearing the end of its design life and some Terra Linda residents, including the Santa Margarita Neighborhood Association, would like to see the creek restored to a more natural condition.

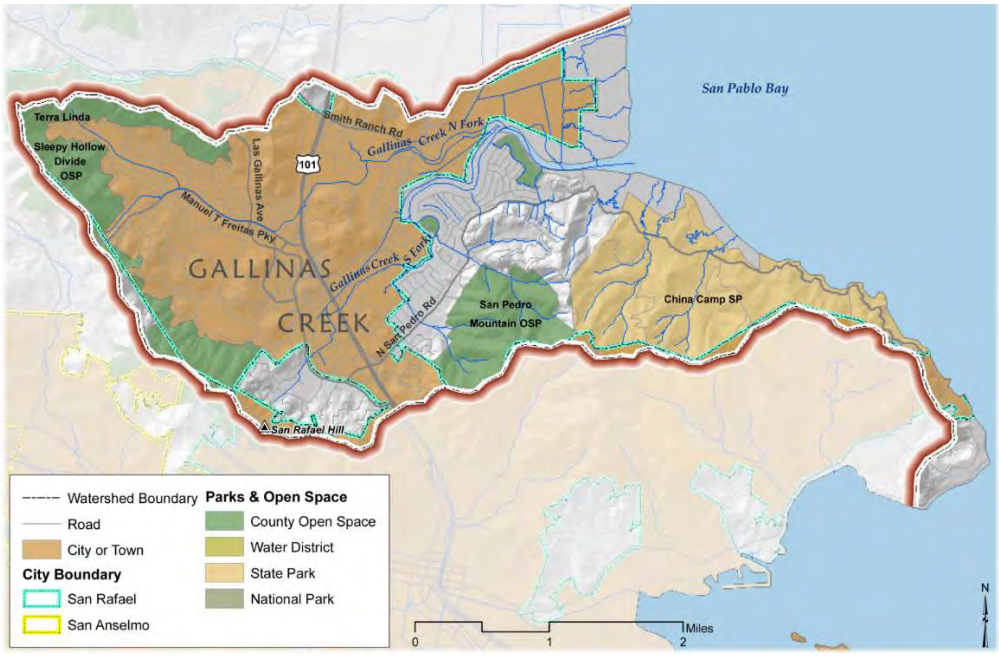

FIGURE 1: GALLINAS CREEK WATERSHED

A natural creek condition with native vegetation would provide wildlife habitat and corridors, improved aesthetics, and new recreational opportunities if walking and bicycling paths are included in the new creek alignment. Obstacles to natural channel restoration include cost, ability to convey storm flows, and land ownership.

In 2004, Kamman Hydrology and Engineering, Inc. (KHE) produced the Gallinas Creek Restoration Feasibility Study and Conceptual Design Report, a concept-level feasibility study that analyzed four alternatives for restoring the channel. The study was directed by Friends of Gallinas Creek and funded by the San Pablo Bay Watershed Restoration Program Partners (U.S. Army Corps of Engineers, San Francisco District, and California Coastal Conservancy). It provides much of the basis for this restoration opportunities study.

The Gallinas Watershed Program (a partnership between County of Marin Department of Public Works, Flood Control Zones 6 and 7, County Service Area No. 6, Las Gallinas Valley Sanitary District, Marin County Parks, and the City of San Rafael) produced the Restoration Opportunities Study to assess what a natural channel alignment could look like within existing public rights of way.

This Restoration Opportunities Study focuses on the approximately 0.75-mile-long reach of the North Fork of Gallinas Creek along Freitas Parkway from Montecillo Road to Los Gamos Road (Figure 2). This reach flows in an open concrete-lined channel and has become perennial (flows all year) due to residential irrigation runoff and the non-permeable concrete channel bed. The concrete channel is not uniform throughout its length; therefore, this study considers four cross-sections in the following reaches:

- Monticello Road to Del Ganado Road
- Del Ganado Road to Las Pavadas
- Las Pavadas Avenue to Las Gallinas Avenue
- Las Gallinas Avenue to Los Gamos Road/Northgate Drive

FIGURE 2: STUDY REACHES

This memo summarizes findings from the KHE 2004 report and provides conceptual schematics showing three different alternatives for what a restored channel could look like. The memo also summarizes the preliminary basis for the channel design and evaluates and compares each alternative based on a series of metrics including cost, environmental enhancement, and community benefits.

TWO | EXISTING CONDITIONS

Watershed and Subreach Descriptions

Historical Conditions

FIGURE 3: 1953 PHOTOGRAPH OF TERRA LINDA, COURTESY OF THE MARIN HISTORICAL SOCIETY

FIGURE 4: 1959 PHOTOGRAPH OF TERRA LINDA, COURTESY OF THE MARIN HISTORICAL SOCIETY

Historically, the upper watershed and valleys of Gallinas Creek supported vegetation of oak-bay woodlands and native grasslands. The creek corridor supported patches of riparian vegetation including willows, California blackberry and coast live oak. Beginning in the 1840s, cattle grazing began in earnest, leading to the loss of riparian vegetation, creek incision, and a decrease in the diversity of native species. Dairy cattle grazing continued through most of the watershed into the 1900s. Early maps and oral histories indicate that the creek was intermittent (dry in the summer, flowing in the winter) well into the 20th Century (KHE 2004).

Figure 3 shows the watershed in 1953, prior to the major development that occurred in the post-war years. The creek corridor appears deeply incised and lacks extensive riparian vegetation - typical of creeks in highly grazed areas (KHE 2004).

Development in the valley areas west of Highway 101 began around 1950, and the North Fork of Gallinas Creek and its tributaries were channelized along Del Ganado Road and Manuel T. Freitas Parkway, following the historic creek alignment. By 1959 (Figure 4), development within the valley floor had all but eliminated all signs of the natural vegetation.

The history of the watershed is described in greater detail in Gallinas Creek Restoration Feasibility Study and Conceptual Design Report (KHE 2004).

Existing Creek Network

The North Fork of Gallinas Creek (Upper Gallinas Creek) originates in the Terra Linda/Sleepy Hollow Open Space Preserve and flows through the Santa Margarita Valley and the community of Terra Linda to its confluence with South Gallinas Slough near McInnis Park.

The headwaters of the North Fork flow in an open, natural channel for approximately 800 feet before entering a stormwater culvert under Del Ganado Road at the edge of residential development. The creek flow in the headwaters is ephemeral; the short length and steepness mean the creek only carries flow during and shortly after rain events.

Tributaries that drain the surrounding hillslopes work their way through the developed valley and flow into the storm drain system that eventually discharges into the mainstem of Gallinas Creek. Larger tributaries enter Gallinas Creek at Freitas Parkway and Del Ganado Road; from the north and south at Las Pavadas Avenue; and again, from the north and south at Las Gallinas Avenue.

The main channel of the North Fork follows the alignment of Del Ganado Road to the intersection with Freitas Parkway. From there, it runs along Freitas Parkway to Highway 101. In the study reach, the creek flows down the middle of Freitas Parkway. On both the north and south side of the creek, the Parkway consists of two lanes of traffic, a bike lane, and a sidewalk. When built, the Parkway was intended to extend to Ross Valley to the west and Lucas Valley (by way of Del Ganado Road) to the north. These connections were never made and the Parkway is likely oversized for the amount of traffic it conveys.

Existing vegetation in the watershed includes oak-bay woodlands, open grasslands, and chaparral. Soils are shallow and geology is generally unstable. Heavy rains can result in landslides and erosion in steep

terrain. Along the project reach in Freitas Parkway, the creek is concrete-lined with non-native shrubs on the banks including juniper, pyracantha, and bottlebrush, among others. Birds and small mammals (rats, raccoons, possums) likely use the channel and narrow vegetated areas, but the overall quality of habitat is low.

Summer flows in the North Fork of Gallinas Creek are of poor quality and contribute to degraded water quality conditions downstream.

Subreaches

The focus of this study is the approximately 0.75-mile-long reach of the North Fork of Gallinas Creek along Freitas Parkway from Montecillo Road to Los Gamos Road. This reach consists of four subreaches: Monticello Road to Del Ganado Road; Del Ganado Road to Las Pavadas Avenue; Las Pavadas Avenue to Las Gallinas Avenue; and Las Gallinas Avenue to Los Gamos Road/Northgate Drive.

TABLE 1: SUBREACH CHARACTERISTICS

Location	Drainage Area (sq mi)	Local Channel Slope	Channel Top Width (ft)	Corridor ROW (ft)
Monticello Road	0.3	0.0213	16	38
Del Ganado Road	1.0	0.0093	16	38
Las Pavadas Avenue	1.3	0.0074	25	38
Las Gallinas Avenue	2.3	0.0047	25	48

Figure 5: Monticello Road to Del Ganado Road

Figure 6: Las Pavadas to Las Gallinas

Figure 7: Del Ganado to Las Pavadas

Figure 8: Las Gallinas to Northgate Drive

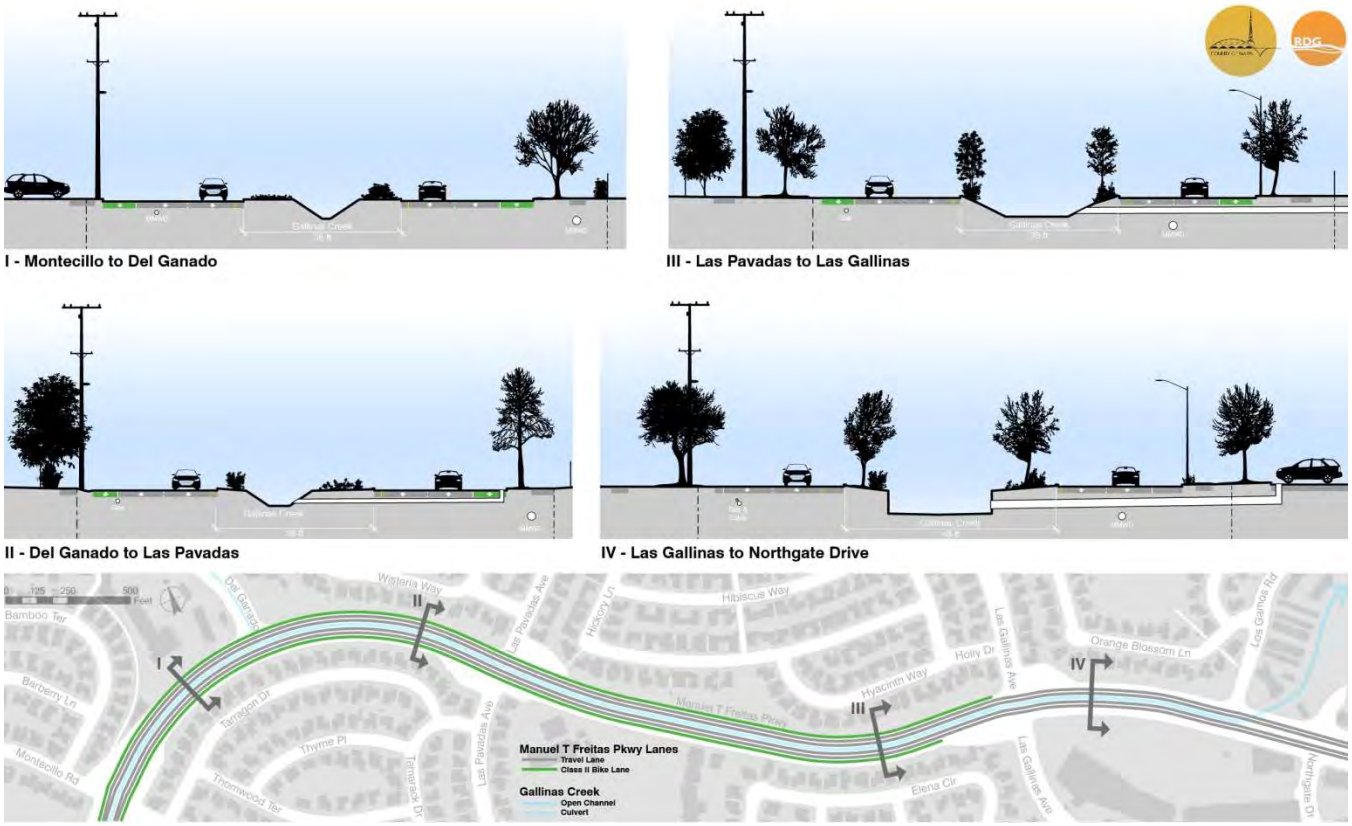

FIGURE 9: EXISTING CONDITIONS

MONTICELLO ROAD TO DEL GANADO ROAD

The Monticello Road subreach is the steepest and the furthest upstream subreach in the study area. The creek channel is 16 feet wide, concrete-lined, and flows within a 38-foot right-of-way. A typical cross-section of the creek and parkway is shown in Figure 5. A photo of the subreach is included in Figure 9.

DEL GANADO ROAD TO LAS PAVADAS AVENUE

The Del Ganado Road subreach is the next downstream subreach. The creek channel is 16 feet wide, concrete-lined, and flows within a 38-foot right-of-way. A typical cross-section of the creek and parkway is shown in Figure 6. A photo of the subreach is included in Figure 9.

LAS PAVADAS AVENUE TO LAS GALLINAS AVENUE

The Las Pavada Avenue subreach is the next downstream subreach. The creek channel is wider (25 feet wide), concrete-lined, and flows within a 38-foot right-of-way. A typical cross-section of the creek and parkway is shown in Figure 7. A photo of the subreach is included in Figure 9.

LAS GALLINAS AVENUE TO LOS GAMOS ROAD/NORTHGATE DRIVE

The Las Gallinas Avenue subreach is the downstream-most subreach in the study area. The creek channel is 25 feet wide, concrete-lined, and flows within a 48-foot right-of-way. A typical cross-section of the creek and parkway is shown in Figure 8. A photo of the subreach is included in Figure 9.

Utilities

Several utilities traverse and run parallel to Freitas Parkway. Marin Municipal Water District has multiple lines that run along and cross the Parkway. A 24" water main is the only utility that runs parallel to Gallinas Creek on the south side. All other utilities that run along Freitas Parkway do so on the north side. This includes overhead electric lines that follow the north edge of the road right of way. These lines are currently being considered for underground relocation by the City of San Rafael. Gas and fiber optic lines also run under the westbound travel lanes of Freitas Parkway, with the fiber optic lines only found east of Gallinas Avenue. Sanitary sewer lines cross Gallinas Creek at Las Pavadas and Las Gallinas, but do not run down Freitas Parkway. The final utility is the storm drain network that conveys stormwater from the adjacent land on both sides of Gallinas Creek. This network has numerous outfalls into Gallinas Creek within the project area.

The utility locations were collected from each responsible agency and aggregated into a base map used for the development of the concept designs. Utility locations are noted in this document in the existing conditions cross sections. Elevations of the utilities shown in the figures are estimated and will need to be verified prior to final designs.

Hydrology

The contributing drainage area for Gallinas Creek through the project area varies substantially from one end of the project to the other. The upstream end of the project at Montecillo Road receives runoff from 0.3 square miles of hillslope and suburban development. The contributing drainage increases to 2.26 square miles at the downstream end of the project at Las Gallinas Avenue.

The KHE study developed estimated flowrates at the middle of the study area (Las Pavadas Avenue) and found that the channel conveys the fifty-year recurrence interval discharge (Q_{50} flow event). The Q_{50} is a flow rate that is expected to occur every fifty years on average. To capture the flow conditions more accurately, the current project developed flowrates for the four separate sub-reaches.

Gallinas Creek is ungaged and therefore design flows must be estimated rather than developed more directly from a flood frequency curve of measured flow values. For this project, we used regional regression equations to estimate discharge for various design storms. Peak flow rates as determined by the updated USGS regression equations (Gotvald, Veilleux, & Parrett, 2012) are shown in Table 2. for a mean annual precipitation that ranges from 35.5 to 35.8 inches and a drainage area ranging from 0.3 to 2.26 square miles. The set of regression equations used are for the California North Coast Hydrologic Region. These regression equations represent updated statistical analysis at many stream gage sites but do not include any specific local adjustment factors for percent urbanization. To account for urbanization we used an additional set of regression equations (Sauer et al. 1983) that adjust the USGS values based on a basin development factor. See Appendix A – Estimates of peak discharge for additional documentation.

The table below summarizes the flood frequency estimates provided by various sources and methods at different subreaches. The first estimates are those derived from the USGS methodology described above. The second and third (reported in KHE 2004) are a set of regression equations developed by

Rantz in 1971 and correlation of FEMA flood flow estimates of nearby creeks and drainage area. The last set of numbers is from the 2011 Las Gallinas Creek Hydrologic Report prepared by the U.S. Army Corps of Engineers.

TABLE 2: SUMMARY OF ESTIMATES OF PEAK DISCHARGE

Peak Discharge (cfs)	$Q_{1.5}$	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Monticello Rd	40	51	86	112	147	174	200
Del Ganado Rd (Method: USGS)	108	138	234	307	403	476	548
Del Ganado Rd (Method: Army Corps)							740
Las Pavadas Ave (Method: USGS)	142	180	302	394	517	609	701
Las Pavadas Ave (Method: Rantz)		98	187	254	353	525	
Las Pavadas Ave (Method: FEMA)						559	649
Las Pavadas Ave (Method: Army Corps)				372			
Las Gallinas Ave (Method: USGS)	222	284	482	632	829	979	1,129
Las Gallinas Ave (Method: Army Corps)							1500

Opportunities and Constraints

The existing conditions and hydrology of the watershed and subreaches present various opportunities and constraints to which the concept designs must respond.

Opportunities

- The Freitas Parkway corridor offers a continuous band of public land that connects the upper neighborhood with the commercial core of Terra Linda.
- The width of the right-of-way provides significant space for restoration of Gallinas Creek and the creation of a multi-use trail.
- Freitas Parkway may be over-sized given the amount of traffic it conveys
- Enhancements of intersections, such as roundabouts, can be included to improve traffic flow
- Removal of impervious surfaces and inclusion of bioretention where feasible can help the City comply with the National Pollutant Discharge Elimination System (NPDES) storm water program.
- Community interest and support exists for the restoration of the channel and for park and greenway improvements to Freitas Parkway.
- Widening the channel corridor can provide room for habitat and additional flood capacity
- Many components of the City adopted *North San Rafael Vision Promenade Conceptual Plan* can be implement as a part of this project
- Creation of natural areas for recreation and other improvements will provide economic benefit
- Efficiencies can be gained by coordinating the undergrounding of utilities with this project

Constraints

- The relatively smooth concrete-lining of the channel creates a supercritical flow regime during flood events. Water moves quickly through the study area. Replacing the existing concrete-lined channel with earthen and vegetated bed and banks will require larger (i.e. wider) channels to maintain the existing level of flood protection. Depending on the degree of desired restoration, traffic lanes in Freitas Parkway and/or Del Ganado Road may need to be narrowed and/or eliminated.
- The study reach is located along a major thoroughfare. Construction activities during restoration and parkway realignment will be disruptive.
- Creek channel restoration would require expensive earthwork activity and utility and infrastructure relocation.
- Channel bank erosion during flood flows and natural channel migration would require long-term monitoring and maintenance of a restored creek system. Relocating the channel from the middle of Freitas Parkway to one side of the corridor could introduce bank erosion and instability to private property.

THREE | PROPOSED CONDITIONS

Levels of Restoration

As part of a technical training program for flood control engineers, the Waterways Restoration Institute developed the following framework to describe levels of river restoration. The framework is useful in understanding the benefits across the spectrum of possible restoration alternatives.

The highest level of restoration is **Historical Restoration**. This level reinstates the historical conditions to recreate the original pre-settlement riparian environment. Historical Restoration is generally understood to represent a theoretical condition that cannot be implemented in an urbanized landscape due to limitations in right-of-way area and other permanent watershed changes.

Ecological Restoration establishes the fundamental structure and function of the waterway. Structure of the waterway refers to the channel bed, banks, bed load, and the channel geometry (channel slopes, meander, width/depth ratio etc.). It also contains the vegetative structure of the riparian corridor including the canopy, understory, and aquatic plant species. The structure is the foundation of a healthy waterway ecosystem. Ecological Restoration also relies on a breadth of riparian right-of-way that is not always available in urban areas. Maintenance activities for Ecological Restoration focus on increasing species diversity by removing invasive plant species in coordination with planting native species.

Functional Restoration refers to the interaction between physical and biological processes. These processes help establish dynamic channel equilibrium—balancing sediment inputs and outputs, creating aquatic and terrestrial habitat, and enhancing nutrient cycling. Functional Restoration accepts that the existing condition has insufficient channel right-of-way width or hydraulic capacity to allow for a measurable increase in roughness. Roughness describes the flow restricting characteristics broadly affected by channel form and riparian vegetation. One strategy of Functional Restoration is to increase the flood capacity by increasing the available space for the channel. Once capacity is increased, restoration can include riparian vegetation to improve both habitat and water quality.

Achieving Functional Restoration in flood control channels can reduce or eliminate the need for sediment removal—typically the costliest maintenance requirement in conventional flood control channels and cause of the greatest impact to habitat. It can also provide the foundation for future comprehensive restoration efforts. Functional Restoration typically cannot allow for dense riparian vegetation due to its effects on channel capacity. It can accept significant additions of vegetation in specific areas, designed in a manner that accommodates active vegetation management. Maintenance activities associated with Functional Restoration projects are typically required to cull some portion of channel vegetation on a regular basis to ensure required flood control capacity is maintained.

The final, most modest level, is **Controlled Channel Enhancements**. Controlled Channel Enhancements do not actually represent waterway restoration as they do not assist in the recovery of the waterway ecosystem in a manner that can lead to the implementation of restoration efforts in the future. They are generally conducted outside of the channel and include landscaping, public access, or interpretive elements. Controlled Channel Enhancements can provide important upland habitat.

Summary of Proposed Alternatives

1 – Alternative A – Restore In Place (Functional Restoration)

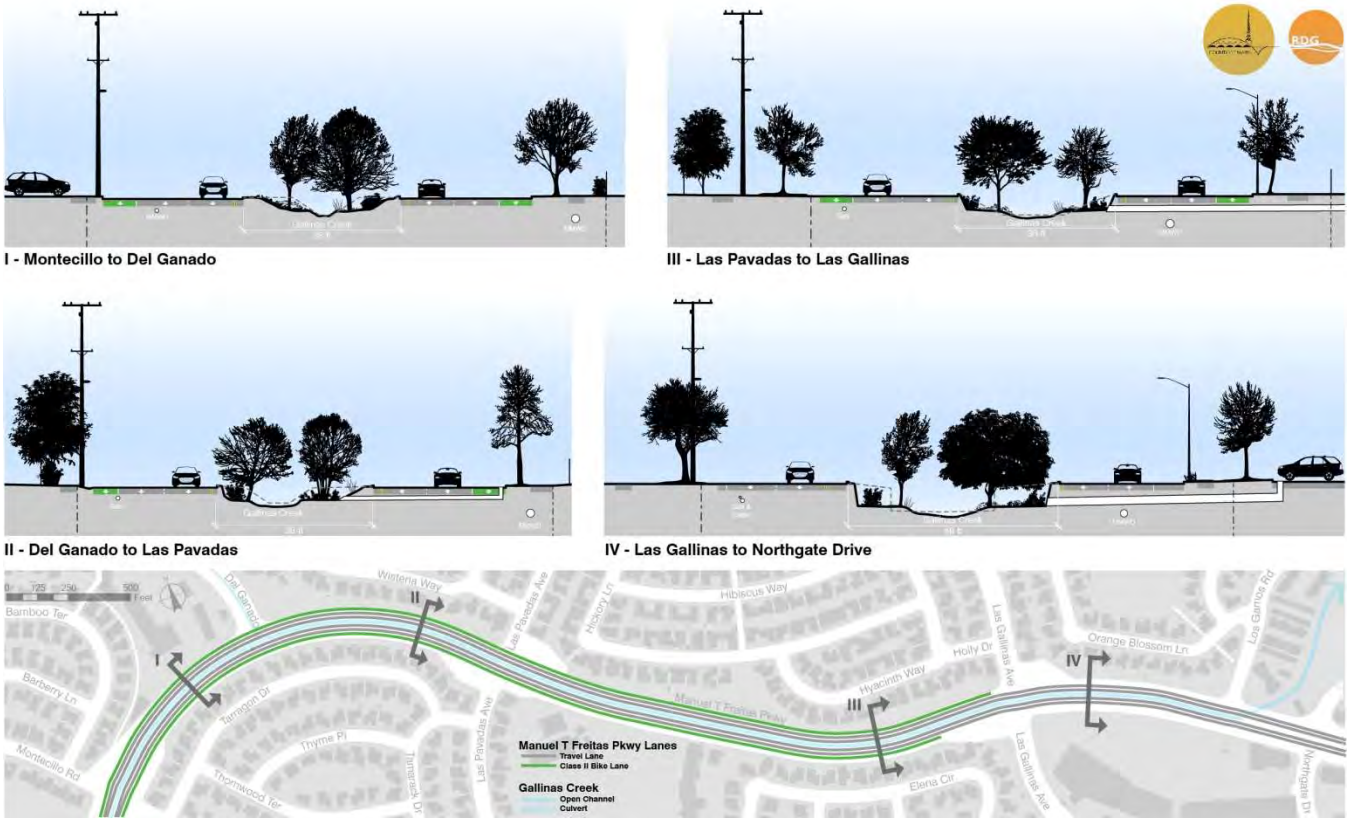

FIGURE 10: ALTERNATIVE A - RESTORE IN PLACE

Maintain existing road configuration; Remove channel concrete sides and bottom; channel bottom replaced with natural channel; natural and armored banks that permit vegetation (Figure 10).

- Improves water quality
- Improves habitat modestly
- Limited access to the creek due to location within road median
- Sediment management requirements need further study
- Increases available channel flow area
- Feasibility depends on ability to maintain flood flows and manage sediment
- Amount of vegetation permitted and amount of vegetation maintenance required will depend on flood capacity

2 – Alternative B – Restore with Greenway and High-Flow Bypass (Functional Restoration)

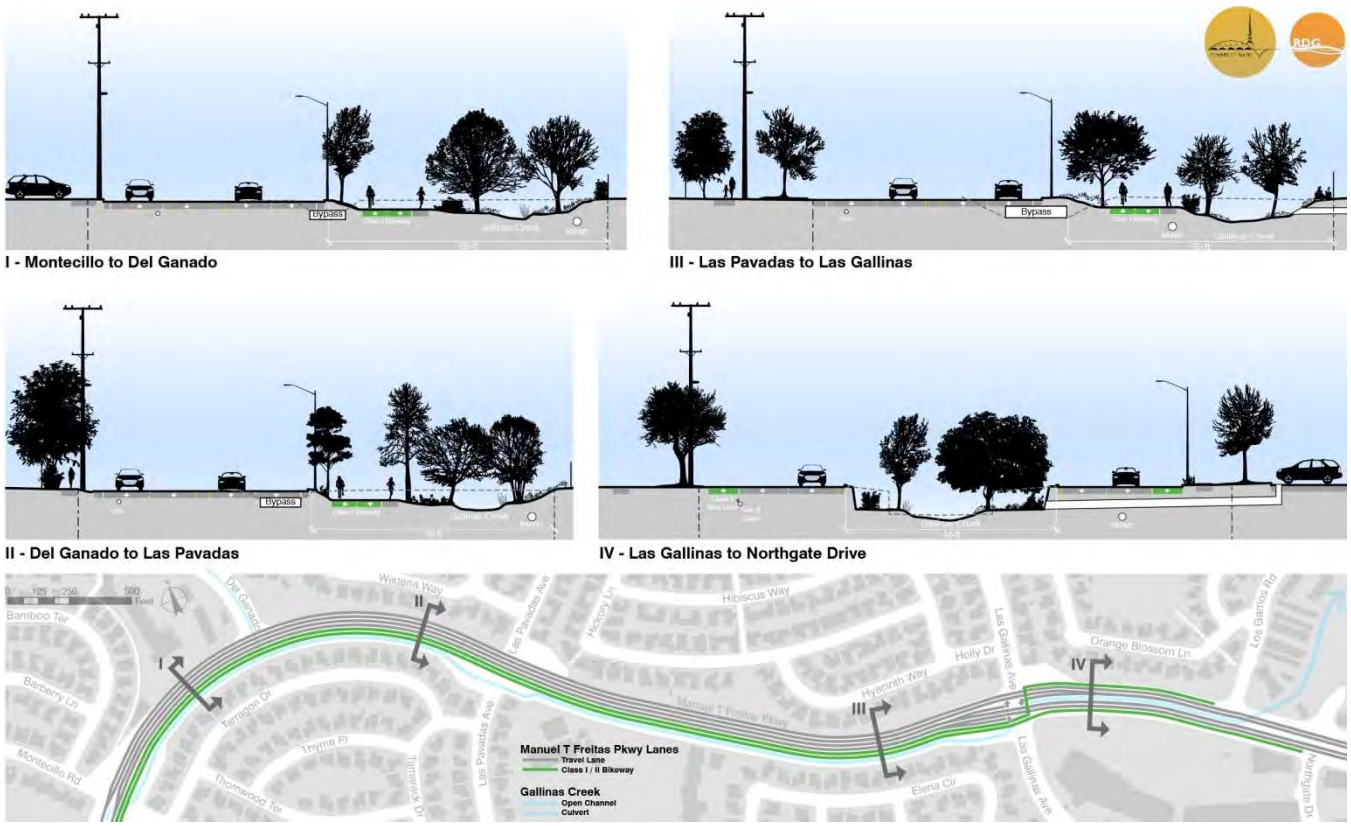

FIGURE 11: ALTERNATIVE B - RESTORE WITH GREENWAY

Realign creek to one side of the road; maintain traffic lanes; add Class1 bikeway and pedestrian path along restored creek channel; provide high flow bypass for flood flows (Figure 11).

- Earthen bed and banks
- Large buried storm drain for high flows to mitigate flood flows
- Feasibility depends on ability to maintain flood flows and infrastructure and traffic constraints
- Promotes natural geomorphic processes and ecological function
- Provides increase in density of native riparian vegetation due to greater flood capacity
- Greater flood capacity may reduce maintenance burden

3 – Alternative C – Full Restoration with Enhanced Greenway (Ecological Restoration)

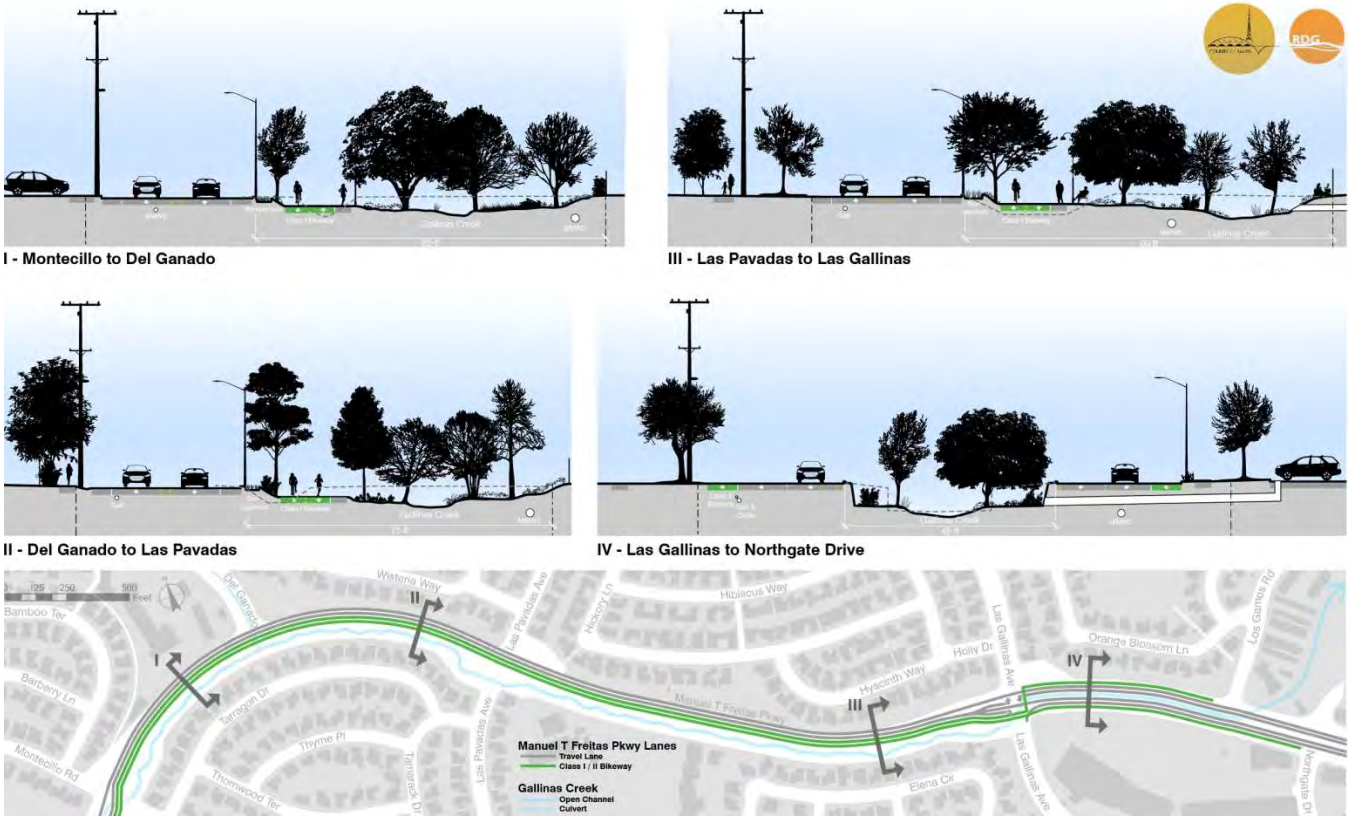

FIGURE 12: ALTERNATIVE C - FULL RESTORATION WITH ENHANCED GREENWAY

Realign creek to one side of the road; reduce traffic lanes; add Class1 bikeway and pedestrian path along restored creek channel (Figure 12).

- Provides widest greenway corridor with significant recreational opportunities and ability to connect to the creek
- Provides most flood capacity of the three alternatives
- Reduces paving and provides greatest room for green infrastructure adjacent to road
- Provides room for restoration of meandering channel planform
- Feasibility depends on infrastructure and traffic constraints and costs
- Greatest habitat and water quality improvements

Geomorphic Design

Geomorphic design provides a series of geometric parameters that affect the physical performance and health of the creek channel over time. This physical structure determines the ecological function of the creek and riparian ecosystem. It is for these reasons that geomorphic design provides the foundation for the design of stream restoration projects.

For Gallinas Creek, we determined the geomorphic design at this stage of the project to understand better the spatial relationship between the function of the creek channel and the other uses that occur within the right-of-way of Freitas Parkway.

The geomorphic design is defined by 1) a set of parameters collectively referred to as hydraulic geometry and; 2) planform parameters that define the meander pattern and planform variability of the channel. The geomorphic design used to develop the channel designs used in the concept alternatives is below.

Hydraulic Geometry

The parameters summarized in Table 3 summarize the appropriate hydraulic geometry of the low flow channel of Gallinas Creek given the size of the watershed, slope of the channel and amount and type of sediment transported by the creek during storms. A summary of our approach to developing the hydraulic geometry can be found in Appendix B – Hydraulic Geometry Design Basis.

Hydraulic geometry includes measurements for the channel top width, average depth, cross sectional area, and width-to-depth ratio (W/D Ratio). This geometry is appropriate for the planning level analysis and will be refined as the design advances and sediment dynamics become more understood.

TABLE 3: PROPOSED HYDRAULIC GEOMETRY

Location	Width (ft)	Depth (ft)	Area (sf)	W/D Ratio
Below Monticello	14.2	0.6	8.5	23.9
Below Del Ganado	18.5	1.1	20.3	16.8
Below Las Pavadas	20.0	1.3	26.0	15.4
Below Las Gallinas	26.0	1.8	46.8	14.4

Planform Geometry

Parameters such as meander length, belt width, and radius of curvature describe planform geometry of natural channels. Analysis of the patterns and relationships of planform geometry has led to regime equations that relate these metrics to hydraulic geometry parameters of cross sectional area, width and depth and can be useful as a planning level tool to evaluate whether proposed alignments are within the range typically found in natural channels. We reference this planform geometry for the layout of new sections of channel proposed in alternatives B and C. The results of the review of the regime equations are summarized in Table 4.

TABLE 4: REGIME EQUATION PLANFORM GEOMETRY

Location	Meander Length			Belt Width			Radius of Curvature			Length Bend		
	Min	*Mid*	*Max*	*Min*	*Mid*	*Max*	*Min*	*Mid*	*Max*	*Min*	*Mid*	*Max*
Below Monticello	73	**120**	198	40	**68**	119	16	**24**	37	50	**81**	134
Below Del Ganado	104	**171**	282	56	**97**	169	22	**34**	53	70	**116**	191
Below Las Pavadas	114	**186**	307	61	**106**	184	24	**37**	58	77	**126**	208
Below Las Gallinas	152	**250**	412	82	**142**	247	32	**50**	77	103	**169**	279

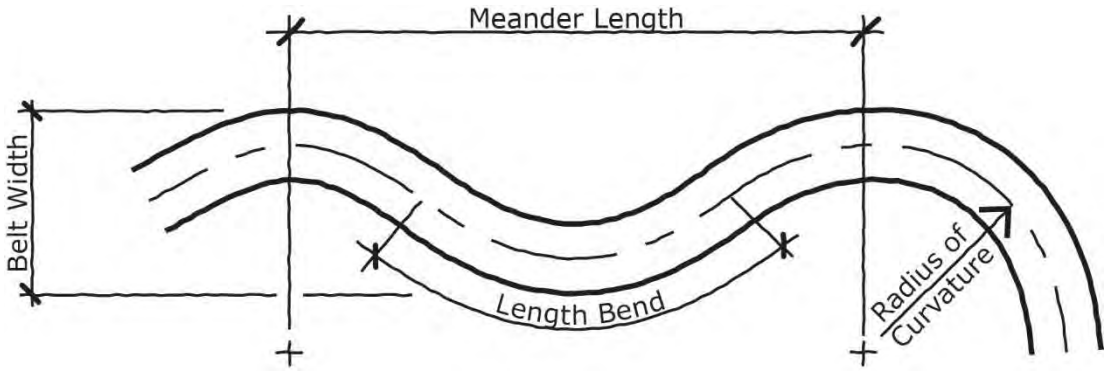

FIGURE 13: PLANFORM GEOMETRY

With Gallinas Creek, we also have the ability to review the historical alignment from historical USGS maps and aerial photography that capture the channel condition prior to the channelization that occurred in the 1950's. Review of the1954 USGS topographic map alongside a 1953 photograph of Santa Margarita Valley (present day Terra Linda) reveals that much of the detail of the channel alignment was not included in the USGS map; however, the photograph does show the historical planform of the channel through the Santa Margarita Valley appears to be within the range developed from the regime equations.

During design development, the alignment and layout of the proposed channel can be vetted using these parameters. One, or preferably, two-dimensional hydraulic modeling should ultimately assess the overall channel layout prior to completion of the final design.

Sediment Assessment

Understanding the current and future sediment characteristics of the watershed and channel network will be an important aspect of the restoration planning moving forward. Estimates provided by the City of San Rafael for annual removal of sediment from the existing channel network approach 80 tons.

The task of removing this sediment is a significant maintenance burden for the City of San Rafael. Any future restoration work or channel improvements will need to address the on-going effort to remove sediment from the channel.

Preliminary review of the sediment sources and channel conditions within the watershed indicate that the upper watershed tributaries, draining primarily protected open space, provide a moderate source of both fine and coarse sediment prior to entering the storm drain system that feeds the concrete channels along Freitas Parkway. Medium to large cobble (90-180mm) were typically present in the channels at the entrances to the storm drain system. This size class was not evident in the concrete portions of the channel downstream during our site visits. The concrete channels had areas of small deposits (<5 cubic yards total) of muck to fine gravel (<2-16mm) in discrete locations along the channel, with the greatest area of deposition in the twin culverts at the intersection of Del Ganado and Las Ovejas Avenue.

Sediment continuity through the project site is expected to be achievable with the implementation of the correct channel hydraulic geometry. Given the space and correct geometry, a channel in dynamic equilibrium would transport sediment through the system without the need for ongoing sediment removal. The ability to allow sediment transport to remain uninterrupted through the restoration site will be contingent on the chosen concept alternative. A more limited restoration approach, such as Alternative A, may not provide enough flood capacity to allow for the natural flux of sediment in the system.

Further study can verify whether allowing for sediment continuity is an appropriate goal for Gallinas Creek; both in terms of flood capacity within the project reach and in terms of sediment deposition in the lower estuary. Although fluvial input of sediment can help build marshplain and provides significant ecological benefits, it may become a maintenance burden if deposition occurs in areas that limit flood capacity or practical use of the tidal channels in the lower estuary.

If sediment continuity is determined not to be an appropriate option, the community should consider sediment basins within the watershed to simplify the sediment removal process. The choice of how to address sediment management within the watershed will need to weigh carefully the costs of:

- Performing sediment removal in the upper watershed versus the estuary
- The disturbance to the sensitive creek and riparian resources caused by sediment removal
- The loss of ecological and geomorphic function that will occur if the bed load is removed
- Any impacts to flood capacity of the channel throughout the length of the creek network
- Permitting and regulatory agency review
- Accessibility to maintenance areas and the ease of performing the maintenance work

Preliminary Costs

We developed construction cost estimates for each conceptual design alternative to assist in the evaluation of alternatives. The cost estimates reference unit costs from previously constructed projects and cost summaries from CalTrans and Marin County Department of Public Works where applicable. The costs include design and assessment phase work and a 25 percent contingency for construction. The costs also include an escalation forecast for an assumed project construction date of 2020. For planning purposes, it is reasonable to anticipate the expenditure of the entire contingency.

The cost estimates include work required to implement the three alternative creek and greenway designs including the creek, greenway and road improvements for the entire project reach but do not include additional opportunistic work such as undergrounding or replacement and repair of utilities that may be integrated into the project at the discretion or direction of the utility agencies.

The following is a summary of the project costs. For a complete itemized estimate, see Appendix B.

TABLE 5: SUMMARY OF PRELIMINARY COST ESTIMATES

	Alternative A Restore in Place	Alternative B Restore with Greenway	Alternative C Full Restoration
Design & Construction Admin.	$2,508,000	$3,946,000	$3,485,000
Construction Total	$6,100,000	$9,500,000	$8,385,000
PROJECT TOTAL	**$10,345,000**	**$16,276,000**	**$14,375,000**

Significant costs associated with the retaining walls required for Alternative A increase the cost for this alternative. Alternative B costs are elevated primarily due to the costs of the bypass culvert installation. As the design process moves forward the need for the bypass culvert for Alternative B can be evaluated. It may be found that a hybrid between Alternatives B and C is feasible, where the traffic lanes remain without the need for a bypass culvert.

Conceptual Design Alternatives Analysis

Each of the three conceptual designs appears to be feasible at this stage. There is potential that Alternative A, which replaces the concrete channel with a natural channel within the existing confined creek corridor, will reduce flood conveyance capacity for Gallinas Creek. This would require additional flood protection measures that could prove to make this alternative unfavorable. The 2004 *Gallinas Creek Restoration Feasibility Study and Conceptual Design Report* concluded that this alternative *would* likely be feasible from a flood conveyance standpoint. Alternatives B and C are expected to provide an increase in flood conveyance capacity.

We ranked the three alternatives for a series of metrics for comparative purposes. Each metric supports a separate goal or opportunity for improvement for the project.

TABLE 6: RANKING OF ALTERNATIVES

	Alternative A	Alternative B	Alternative C
Complete Streets	★	★★★	★★★
Green Infrastructure	★	★★	★★★
Park Space	☆	★	★★
Promenade	★	★★	★★★
Safe Routes to School	☆	★★★	★★★
Microclimate Enhancement	☆	★★	★★★
Flood Risk Reduction	☆	★★	★★★
Habitat Improvement	★	★★	★★★
Water Quality Benefit	★	★★	★★★
Maintenance Reduction	★	★★	★★★
Permitting Ease	★	★★	★★★
Funding Availability	☆	★★	★★
Phasing	★★★	★	★
Cost	$$	$$$	$$
Community Support	?	?	?

Marginal to no improvement	☆
Limited improvement	★
Moderate improvement	★★
Most improvement	★★★

Complete streets encapsulates the notion that a street should be equally effective for all types of transportation alternatives including transit, car, bicycle and pedestrian. Since Alternative A does not directly change the street and does not preclude these street improvements from occurring, it receives a single star. Both Alternative B and C provide ample room and opportunity to improve the street design and to reduce conflicts at intersections.

Green infrastructure focuses on replicating naturally functioning systems to mitigate impacts of developed land has on stormwater volume and quality. Rain gardens and bioretention facilities are two of the more popular methods to slow and treat stormwater runoff from roads and other impervious surfaces. Due to space constraints, Alternative A has limited opportunities to incorporate green infrastructure. Both Alternatives B and C have the space to treat stormwater prior to entering Gallinas Creek. Alternative C takes green infrastructure a step further by reducing impervious surfaces.

Park space can be provided within the right-of-way if the traffic lanes are reconfigured. Alternative C provides the greatest opportunity for park space due to the reduction in vehicular travel lanes.

Opportunities to develop Freitas Parkway into a **promenade** as envisioned by the *North San Rafael Vision Promenade Conceptual Plan* are considerable. Again, the elimination of travel lanes provides the greatest space and opportunity for promenade elements to move forward.

Similarly, **Safe Routes to School** is a program that encourages children to be able to travel to and from their homes safely. Both Alternative B and C allow for a separated Class 1 Bikeway along the restored creek. The bikeway configuration also allows for greenway traffic to avoid the Del Ganado intersection entirely. Currently westbound cyclists and pedestrians must cross Del Ganado.

Shade from street trees can improve air quality and reduce summertime temperatures. Daytime temperature reduction is a function of riparian corridor width and reductions of up to 10 degrees can be expected under fully mature riparian canopy. Alternate C provides the greatest **Microclimate enhancement** due to having the most robust riparian corridor of the three alternatives.

Alternative A may not provide much **flood risk reduction** benefit due to the existing constrained creek corridor that is maintained for this alternative. The increased room afforded by Alternative C provides the greatest benefit.

Habitat and **water quality** improvement as well as a reduction in **maintenance** are all incrementally improved moving from Alternative A to B to C. The greater width of Alternative C allows for a larger more complex riparian corridor of habitat-providing native vegetation. Likewise, water quality and aquatic habitat both benefit from the restored natural channel and associated bankside vegetation. Because Alternative C can provide room for channel meandering, there is a greater length of channel available to clean and filter water. Maintenance requirements are expected to be the highest for Alternative A, which will require maintenance and upkeep of the walls as well as more regular vegetation and debris management. Debris within the channel will be less of a concern for the wider channels of Alternative B and C.

Federal and State agencies including the US Army Corps of Engineers, the California Department of Fish and Wildlife, and the San Francisco Bay Regional Water Quality Control Board regulate work done in Gallinas Creek. Each of these agencies' involvement is directed towards protecting and enhancing habitat and water quality. Because all three alternatives provide some level of water quality and habitat improvements, **permitting** is expected to be feasible. Due to the additional habitat and water quality benefits of Alternative B and C, these are expected to be the most straightforward to permit. Meeting

the various permit conditions typical of street and creek restoration projects is expected to be the easiest within the expanded room afforded by Alternative C.

There are multiple sources of potential **funding** available to help pay for design and construction for this project. The reduction in impervious surfaces and the ability to incorporate green infrastructure strategies in the design opens an opportunity to have nearby confined projects partially fund this project in lieu of treating stormwater on the confined site. In addition, there are numerous state and federal grant programs set up to fund habitat restoration, greenways, green streets, and water quality projects. These competitive grant programs weigh the cost/benefit for each of these projects, making Alternative C the most attractive option from a grant funding perspective.

From an initial **cost** perspective, Alternative A is the least expensive option, however the long-term costs of maintaining and eventual replacement of the retaining walls will result in Alternative A being increasingly more expensive. Considering construction and maintenance costs, it is expected that Alternative A and C will be the least expensive alternative and Alternative B will be the most expensive.

Community support is the final metric used to evaluate each alternative. Community support will play an important role in overall project feasibility. Preliminary feedback to date has indicated strong support for Alternatives B and C; however, this memo offers the community its first opportunity to learn about the potential projects and provide feedback. This feedback will be critical in weighing and selecting the final preferred alternative.

Highest Ranking Alternative and Next Steps

Currently Alternative C appears to be the most promising when weighing all the various opportunities and constraints. It provides the most benefit for nearly every metric and is intermediate in construction costs compared to the two other alternatives. Whether Alternative C emerges as the preferred design is contingent on the feasibility of reducing traffic lanes on Freitas Parkway and on whether there is strong community support. Following feedback from the traffic study and community outreach, a refined concept plan can be used to actively pursue grant funding opportunities.

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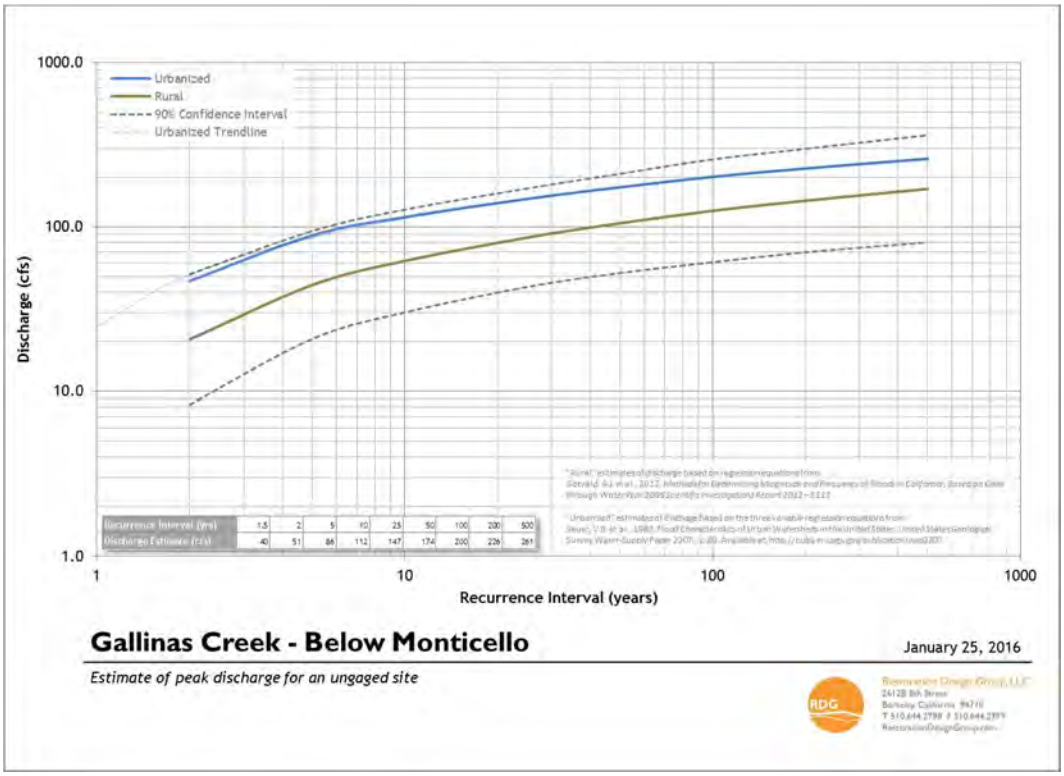
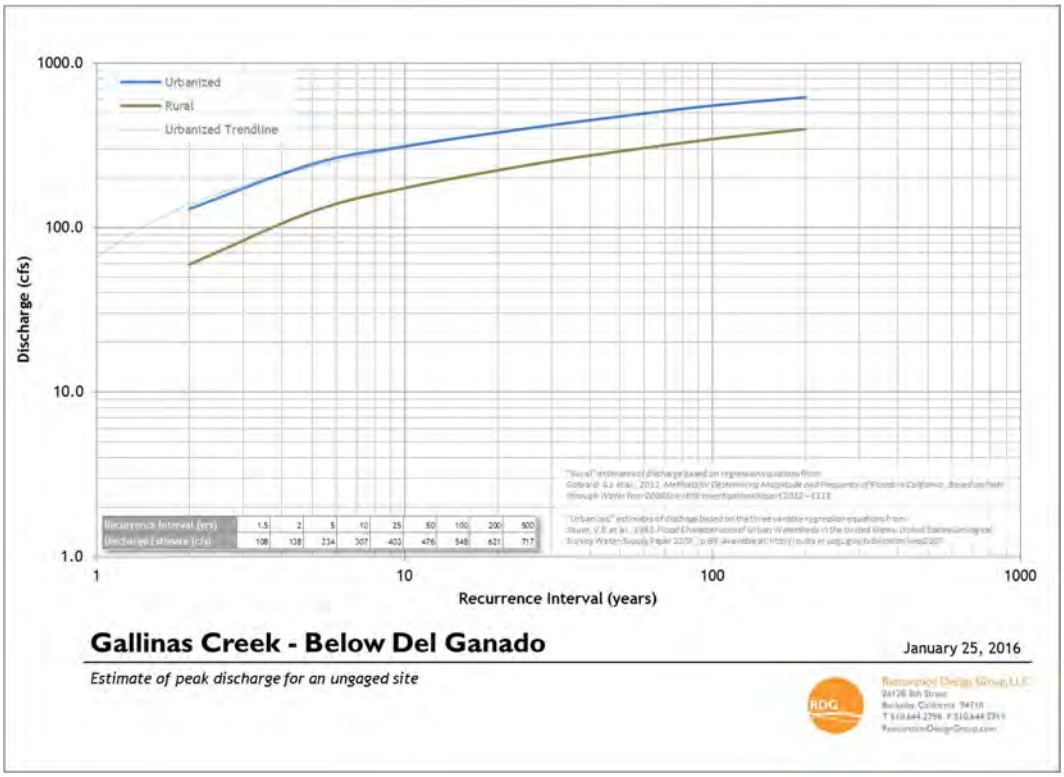
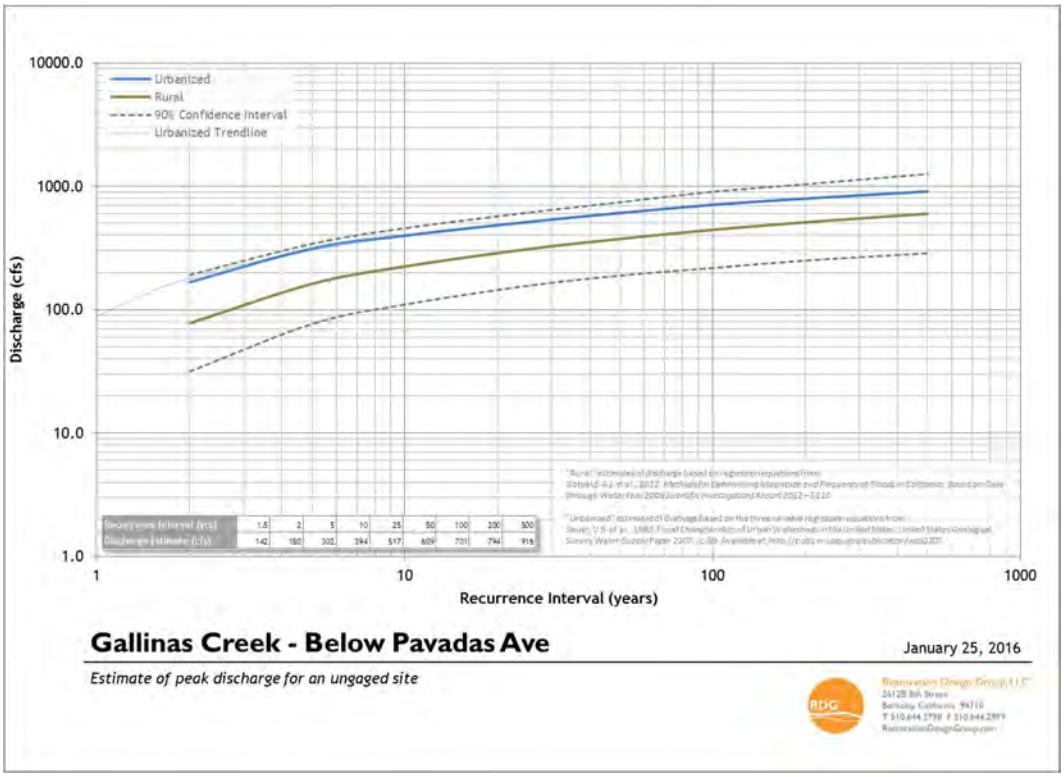
APPENDIX A – ESTIMATES OF PEAK DISCHARGE



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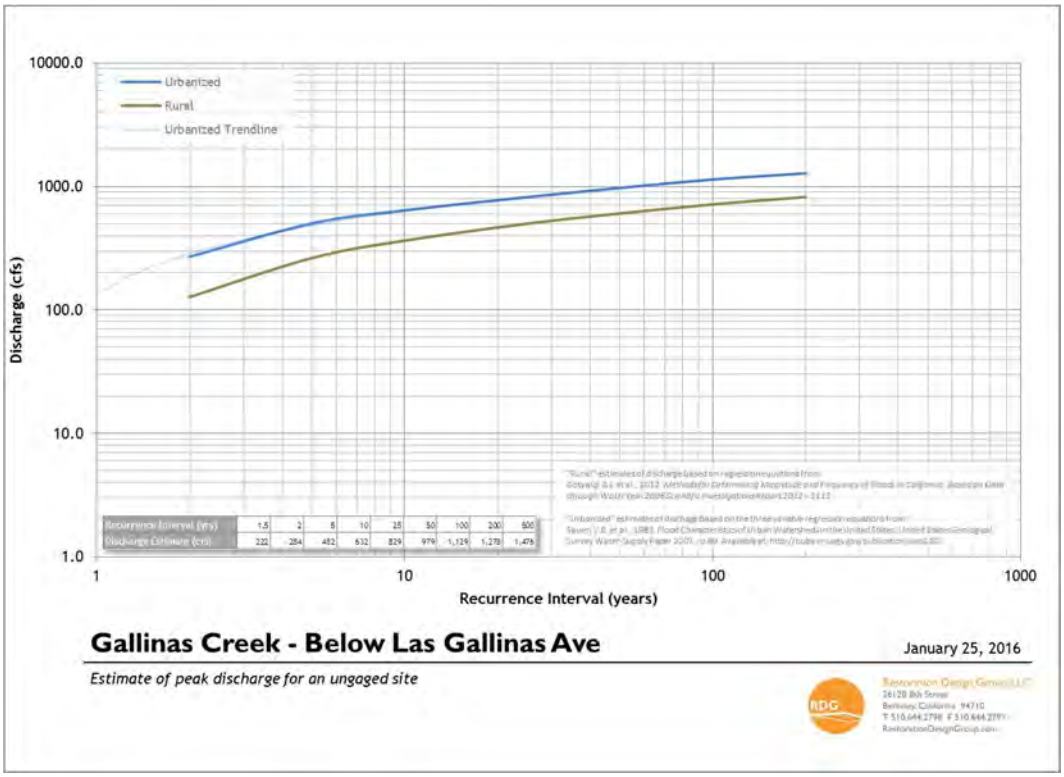
1000.0
100.0
10.0
1.0
Discharge (cfs)
Urbanized
Rural
90% Confidence Interval
Urbanized Trendline
1
10
100
1000
Recurrence Interval (years)
Gallinas Creek - Below Pavadas Ave
January 25, 2016
Estimate of peak discharge for an ungaged site


10000.0
1000.0
100.0
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1.0
Discharge (cfs)
Urbanized
Rural
Urbanized Trendline
1
10
100
1000
Recurrence Interval (years)
Gallinas Creek - Below Las Gallinas Ave
January 25, 2016
Estimate of peak discharge for an ungaged site

APPENDIX B – HYDRAULIC GEOMETRY DESIGN BASIS

The following section provides additional background on the basis for determining the hydraulic geometry for the project.

Hydraulic geometry is based on the theory that for alluvial channels (i.e. channels free to adjust their boundaries to the imposed sediment and water loading conditions) there is an equilibrium set of channel dimensions (i.e. width, depth, cross-sectional area and planform) that are the most efficient in transporting sediment and water without excessive erosion or aggradation of sediment. We derived the hydraulic geometry for the project site from multiple sources including reference sites; regional curves that compile metrics such as width, depth and cross sectional area plotted as a function of drainage area; and hydraulic analysis to evaluate hydraulic grade lines, shear and velocity estimates.

The hydraulic geometry developed for this project provides the necessary conversion from the process-based goals and objectives that drive the development of the restoration concepts to spatial characteristics that can begin to be integrated into the site. The metrics developed as part of the design process equate to the riffle geometry at bankfull flow, or a flow approximating the 1.2-1.6 year recurrence interval peak annual event, which is typical for streams in the San Francisco Bay Area, and include: top width, average depth, cross sectional area, and width-to-depth ratio (W/D Ratio).

REGIONAL CURVE

Regional curves were developed by Dunne and Leopold (1978) to understand the relationship between hydraulic geometry and drainage area for alluvial streams. They remain a useful tool for developing preliminary natural channel designs. The Marin Sonoma Regional Curve was developed in 2013 for the hydrophysiographic region that encompasses the site and was used to develop the following hydraulic geometry estimates for the site. (Collins & Leventhal 2013).

TABLE 7: MARIN SONOMA REGIONAL CURVE

Location	Drainage Area (sq mi)	Width (ft)	Depth (ft)	Area (sf)	W/D Ratio
Below Monticello	0.3	7.4	0.7	4.9	11.1
Below Del Ganado	1.0	12.7	1.0	13.0	12.5
Below Las Pavadas	1.3	14.6	1.1	16.5	12.8
Below Las Gallinas	2.3	18.9	1.4	26.2	13.6

REFERENCE SITES

Three reference sites on Miller Creek, just north of Gallinas Creek, and one site on Sleepy Hollow Creek just to the south of Gallinas Creek, were analyzed to assist in determining the correct hydraulic geometry of the channel. These sites were surveyed as part of the Marin Sonoma Regional Curve work and provide a select review of the most directly applicable sites to the project site. Bankfull dimensions of width, depth, and area were surveyed at each site. Both Miller Creek and Sleepy Hollow Creek have similar hydrology to the project site and provide a suitable direct comparison to likely appropriate hydraulic geometry relationships.

TABLE 8: REFERENCE REACH (COLLINS & LEVENTHAL 2013)

Location	Drainage Area (sq mi)	Width (ft)	Depth (ft)	Area (sf)	W/D Ratio	Bankfull Flow (cfs)	Channel Sediment D_{50} (mm)
Sleepy Hollow Creek	0.41	9.6	0.7	7.1	13.7	33.5	33
Miller Crk North Fork	0.57	12.4	0.9	10.8	13.8	41.4	39
Miller Crk Lucas Site	0.89	17.6	1.1	19.4	16.0	86.9	31
Miller Crk Marinwood	6.36	29.4	1.6	47.2	18.4	234.3	14

Using these four sites, we developed sub-regional curves for width, depth, cross sectional area and bankfull discharge and calculated estimates of project reach hydraulic geometry using the best-fit lines developed from these curves. We expect these hydraulic geometry estimates to be more accurate than the regional curve estimates.

TABLE 9: CALCULATED HYDRAULIC GEOMETRY FROM REFERENCE SITES

Location	Drainage Area (sq mi)	Width (ft)	Depth (ft)	Area (sf)	W/D Ratio	Bankfull Flow (cfs)
Below Monticello	0.3	9.7	0.7	7.2	13.4	30
Below Del Ganado	1	15.3	1.0	15.6	15.2	69
Below Las Pavadas	1.3	17.0	1.1	18.4	15.7	83
Below Las Gallinas	2.3	21.0	1.3	26.6	16.7	124

HYDRAULIC ANALYSIS AND MOBILITY ANALYSIS

As a final method to determine the most appropriate hydraulic geometry for the project we looked at the hydraulics of different channel configurations to confirm the geometry estimates provided by the regional curves and reference reaches.

Using the estimated flowrate of the 1.5-year recurrence interval storm as an approximate surrogate for bankfull discharge, we calculated the hydraulic geometry necessary to contain the flow and compared these values to the regional curve and reference reach values. We also adjusted the W/D ratio to solve for the particle size at the threshold of motion at bankfull flow. For this analysis, we adjusted the grainsize to approximately 45 mm (1.75-inches). This provides consistent sediment transport characteristics between sub-reaches. The results of this analysis are summarized in Table 10. Note that during future design phases it is likely that the threshold grainsize will be adjusted for each reach, which would result in different width-to-depth ratios estimates.

TABLE 10: SUMMARY OF HYDRAULIC ANALYSIS

Location	$Q_{1.5}$ Flowrate	Threshold Grainsize (mm)	Width (ft)	Depth (ft)	Area (sf)	W/D Ratio
Below Monticello	40	45	14.2	0.6	8.5	23.9
Below Del Ganado	108	45	16.6	1.3	21.1	13.0
Below Las Pavadas	142	45	17.9	1.5	27.6	11.6
Below Las Gallinas	222	45	20.4	2.2	44.0	9.5

PROPOSED HYDRAULIC GEOMETRY

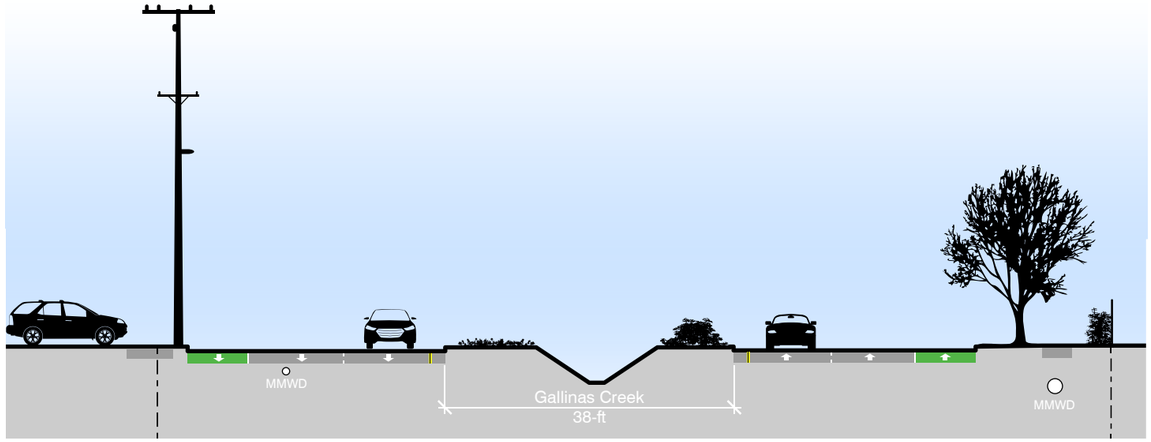
Considering the various methods noted above, we developed a refined estimate of restoration hydraulic geometry. The refinements consider both physical and process based differences between the reference sites and the survey sites used to develop the regional curve. The regional curve sites span a wide breadth of channel types and locations in Marin and Sonoma County, but due to the relative lack of suitable urban sites with stable hydraulic geometry, these sites are underrepresented in the regional curve analysis (Leventhal, personal communication 2016). Thus, the regional curves reflect the more rural, or undisturbed, watershed condition and would likely undersize the hydraulic geometry. The reference reach sites are more urbanized than the average population of sites used for the regional curve, however they too are less urbanized than Gallinas Creek and will also underestimate the bankfull flow and therefore the dimensions of the hydraulic geometry. The resulting estimates provided in the Table 3: Proposed Hydraulic Geometry represents our best understanding of the appropriate channel geometry for each reach. The hydraulic geometry provides a basis for the concept level design. The hydraulic geometry should be modified to reflect changes in the proposed channel roughness and sediment regime.

APPENDIX C – PRELIMINARY COST ESTIMATE

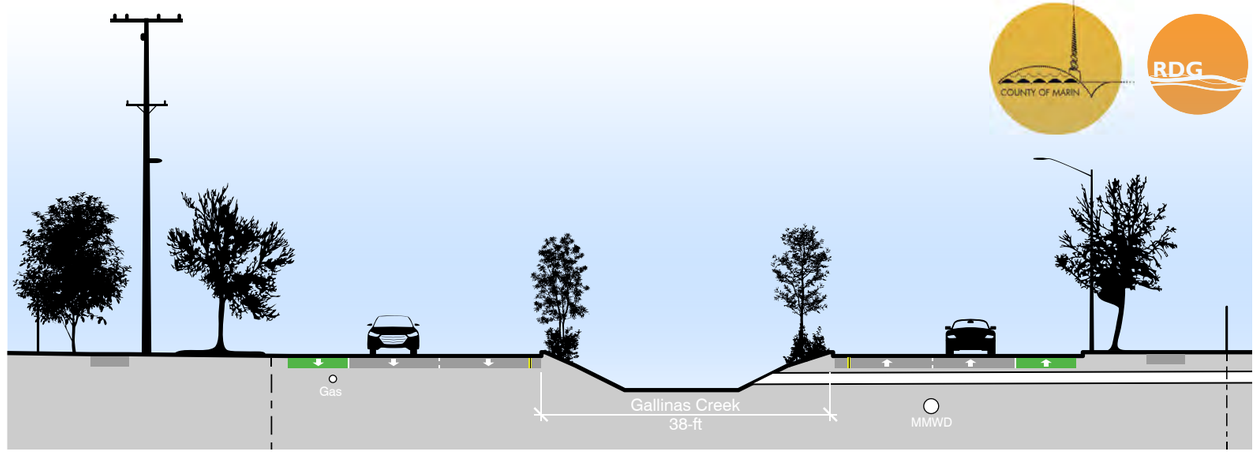
			ALT A - RESTORE IN PLACE			ALT B - RESTORE W/ GREENWAY			ALT C - FULL RESTORATION		
Description	**Unit Cost**	**Unit**	**Qty**	**Total Cost**	**Item Totals**	**Qty**	**Total Cost**	**Item Totals**	**Qty**	**Total Cost**	**Item Totals**
EROSION CONTROL					**$64,170**			**$64,170**			**$64,170**
Straw wattles	$1.40	LF	9550	$13,370		9550	$13,370		9550	$13,370	
Coir Fabric Netting	$540.00	ROLL	60	$32,400		60	$32,400		60	$32,400	
Laborer (3)	$2,300.00	DAY	8	$18,400		8	$18,400		8	$18,400	
DEWATERING					**$86,720**			**$86,720**			**$86,720**
Laborer (3)	$2,100.00	DAY	5	$10,500		5	$10,500		5	$10,500	
6" pipe	$6.60	LF	5200	$34,320		5200	$34,320		5200	$34,320	
6" noise attenuated pump	$6,600.00	MO	5	$33,000		5	$33,000		5	$33,000	
Supervisor/foreman	$800.00	DAY	5	$4,000		5	$4,000		5	$4,000	
Operator (skid-steer)	$980.00	DAY	5	$4,900		5	$4,900		5	$4,900	
DEMOLITION					**$684,615**			**$957,990**			**$957,990**
Culvert Demo and Disposal	$20,000.00	EA	0	$0		3	$60,000		3	$60,000	
Remove sewer/storm drain line	$23.00	LF		$0		550	$12,650		550	$12,650	
Remove concrete curb & gutter	$8.10	LF	11625	$94,163		11625	$94,163		11625	$94,163	
Remove concrete channel (6")	$4.00	SF	127807	$511,230		127807	$511,230		127807	$511,230	
Remove asphalt 4" - 6"	$1.30	SF	0	$0		143250	$186,225		143250	$186,225	
Concrete disposal	$11.00	TON	2875.67	$31,632		2875.67	$31,632		2875.67	$31,632	
AC disposal	$11.00	TON	3008.25	$33,091		3008.25	$33,091		3008.25	$33,091	
Trash disposal	$290.00	LOAD	50	$14,500		100	$29,000		100	$29,000	
CLEARING AND GRUBBING					**$36,170**			**$121,833**			**$121,833**
Clearing and Grubbing	$0.31	SF	48450	$15,020		126720	$39,283		126720	$39,283	
Large tree removal premium	$1,600.00	EA	6	$9,600		32	$51,200		32	$51,200	
Vegetation disposal fees	$33.00	CY	350	$11,550		950	$31,350		950	$31,350	
ROUGH GRADING					**$461,423**			**$1,269,896**			**$1,420,750**
Earthwork - Cut	$7.50	CY	8225	$61,688		25899.2	$194,244		29001.5	$217,512	
Earthwork - Fill	$8.10	CY	0	$0		4519.7	$36,610		5092.24	$41,247	
Soil off-haul - <20 mi Transit Load/Truck/Disposal	$40.00	CY	8225	$329,000		21379.5	$855,179		23909.3	$956,372	
Soil disposal fee (Clean)	$8.60	CY	8225	$70,735		21379.5	$183,864		23909.3	$205,620	
FINE GRADING					**$38,780**			**$60,958**			**$78,430**
Fine Grading	$0.21	SF	184667	$38,780		290275	$60,958		373475	$78,430	
IN-STREAM STRUCTURES					**$161,364**			**$181,764**			**$181,764**
Rootwad	$1,700.00	EA	0	$0		12	$20,400		12	$20,400	
Constructed Riffle	$6.80	SF	23730	$161,364		23730	$161,364		23730	$161,364	
RIPRAP					**$25,000**			**$25,000**			**$25,000**
Rock Slope Protection	$100.00	CY	250	$25,000		250	$25,000		250	$25,000	
BOULDERS					**$0**			**$24,540**			**$42,120**
Creek Access Steps	$2,700.00	EA	0	$0		2	$5,400		4	$10,800	
Landscape Boulders (1-3 ton)	$870.00	EA	0	$0		22	$19,140		36	$31,320	
CULVERTS					**$28,200**			**$1,547,300**			**$384,800**
Headwall	$9,400.00	EA	3	$28,200		7	$65,800		7	$65,800	
High Flow Bypass Culvert	$300.00	LF	0	$0		3875	$1,162,500		0	$0	
20x4 Culvert	$2,200.00	LF	0	$0		145	$319,000		145	$319,000	
WALLS					**$1,958,000**			**$564,667**			**$564,667**
Concrete Retaining Wall	$1,100.00	CY	1780	$1,958,000		513.333	$564,667		513.333	$564,667	
PAVING AND STRIPING					**$1,067,170**			**$1,641,080**			**$1,363,550**
Resin Pavement w/base course @ Plaza Areas	$20.00	SF	0	$0		6000	$120,000		14000	$280,000	
Trail AC Paving (Ton)	$170.00	TON	0	$0		1550	$263,500		1550	$263,500	
Trail Aggregate Base	$36.00	TON	0	$0		1630	$58,680		1630	$58,680	
Road AC Paving (Ton)	$170.00	TON	0	$0		1985	$337,450		0	$0	
Road Aggregate Base	$36.00	TON	0	$0		2780	$100,080		0	$0	
AC - Resurfacing (Ton)	$170.00	TON	3580	$608,600		2280	$387,600		2280	$387,600	
Road Striping	$7.10	LF	5500	$39,050		5500	$39,050		5500	$39,050	
Trail Striping	$4.80	LF	0	$0		4000	$19,200		4000	$19,200	
Concrete Sidewalk, Driveways and Accessible Ramps	$8.20	SF	0	$0		5000	$41,000		5000	$41,000	
Concrete curb and gutter	$29.00	LF	12000	$348,000		7000	$203,000		7000	$203,000	
DRAINAGE STRUCTURES					**$25,200**			**$25,200**			**$25,200**
Outfall 12" - 36" Pipe	$1,400.00	EA	18	$25,200		18	$25,200		18	$25,200	

IRRIGATION					**$162,870**			**$354,127**			**$504,802**
Irrigation - Tree Bubblers and TOB Spray heads	$1.80	SF	89934	$161,881		195542	$351,976		278742	$501,736	
As Builts	$0.01	SF	89934	$989		195542	$2,151		278742	$3,066	
SOIL BIOENGINEERING					**$80,833**			**$80,833**			**$80,833**
Live Poles	$22.00	EA	3183.33	$70,033		3183.33	$70,033		3183.33	$70,033	
Collection of live materials	$2,700.00	DAY	4	$10,800		4	$10,800		4	$10,800	
HYDROSEED					**$10,792**			**$23,465**			**$33,449**
Hydroseed	$0.12	SF	89934	$10,792		195542	$23,465		278742	$33,449	
PLANTING					**$193,114**			**$385,705**			**$496,715**
Planting Area	$1.30	SF	89934	$116,914		195542	$254,205		278742	$362,365	
15 gallon tree	$190.00	EA	180	$34,200		250	$47,500		265	$50,350	
5 gallon tree	$84.00	EA	500	$42,000		1000	$84,000		1000	$84,000	
FENCING AND GUARDRAILS					**$236,640**			**$388,380**			**$388,380**
Road Guardrail	$34.00	LF	6960	$236,640		7920	$269,280		7920	$269,280	
Headwall Guardrail	$260.00	LF	0	$0		160	$41,600		160	$41,600	
6x6 Post and Cable Fence	$20.00	LF	0	$0		3875	$77,500		3875	$77,500	
SIGNAGE					**$0**			**$49,500**			**$49,500**
Interpretive sign	$5,600.00	EA	0	$0		3	$16,800		3	$16,800	
Traffic sign	$1,000.00	EA	0	$0		12	$12,000		12	$12,000	
Trail sign	$2,300.00	EA	0	$0		9	$20,700		9	$20,700	
SITE FURNISHINGS					**$0**			**$523,600**			**$529,800**
Bench - Prefabricated	$3,100.00	EA	0	$0		4	$12,400		6	$18,600	
Bike rack	$1,900.00	EA	0	$0		2	$3,800		2	$3,800	
Pole light - 14' Tall w/pedestal	$8,900.00	EA	0	$0		56	$498,400		56	$498,400	
Trash receptacle	$1,800.00	EA	0	$0		5	$9,000		5	$9,000	
MAINTENANCE					**$9,600**			**$9,600**			**$9,600**
Shrubs - 1 year	$1,600.00	VST	6	$9,600		6	$9,600		6	$9,600	
CONSTRUCTION SUBTOTAL					**$5,331,000**			**$8,386,000**			**$7,410,000**
Mobilization / Bonds / Insurance					**$1,173,000**			**$1,845,000**			**$1,630,000**
Construction Contingency (Approx. 25%)					**$1,333,000**			**$2,097,000**			**$1,853,000**
CONSTRUCTION TOTAL					**$7,837,000**			**$12,330,000**			**$10,890,000**
DESIGN, PERMITTING AND CONSTRUCTION ADMINISTRATION					**$2,508,000**			**$3,946,000**			**$3,485,000**
PROJECT TOTAL					**$10,345,000**			**$16,276,000**			**$14,375,000**
			ALT A - RESTORE IN PLACE			**ALT B - RESTORE W/ GREENWAY**			**ALT C - FULL RESTORATION**		

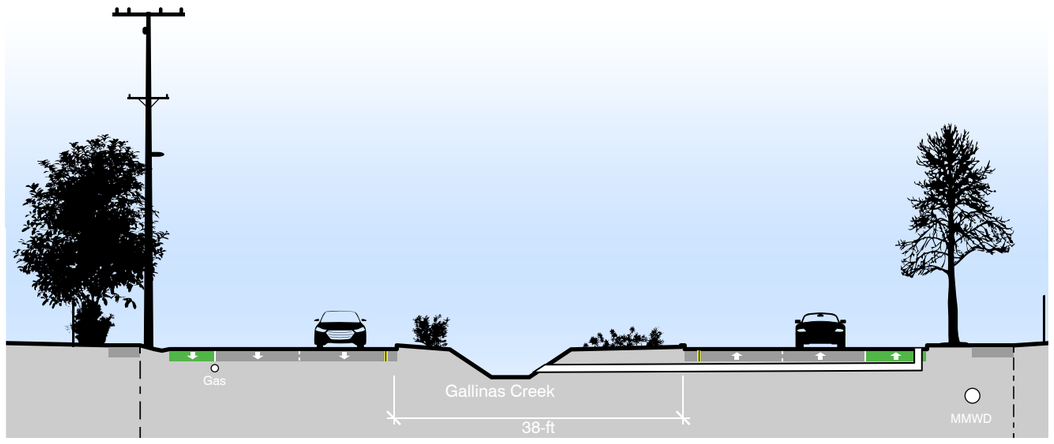
APPENDIX D – CONCEPT DIAGRAMS



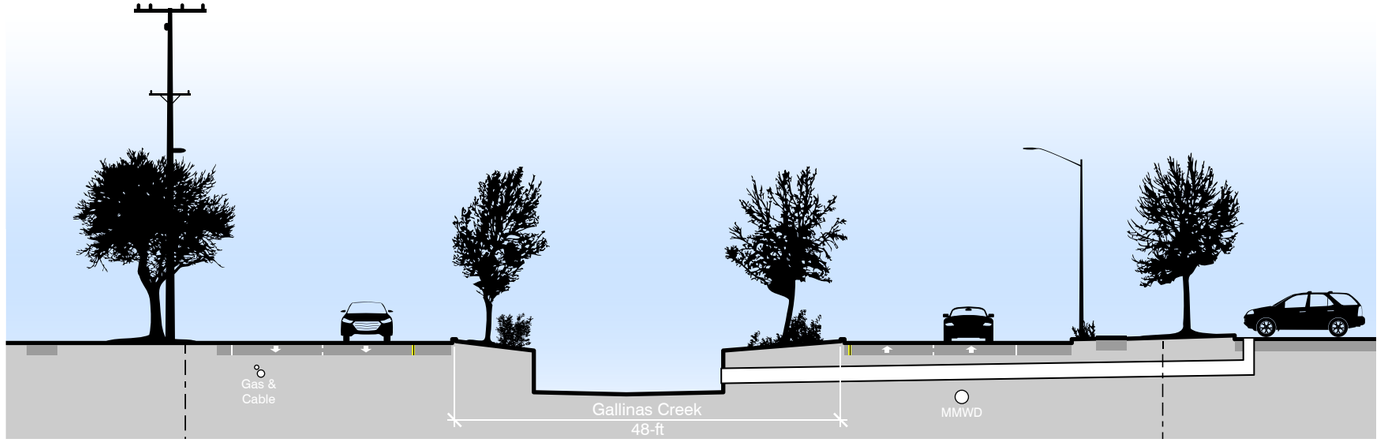
I - Montecillo to Del Ganado



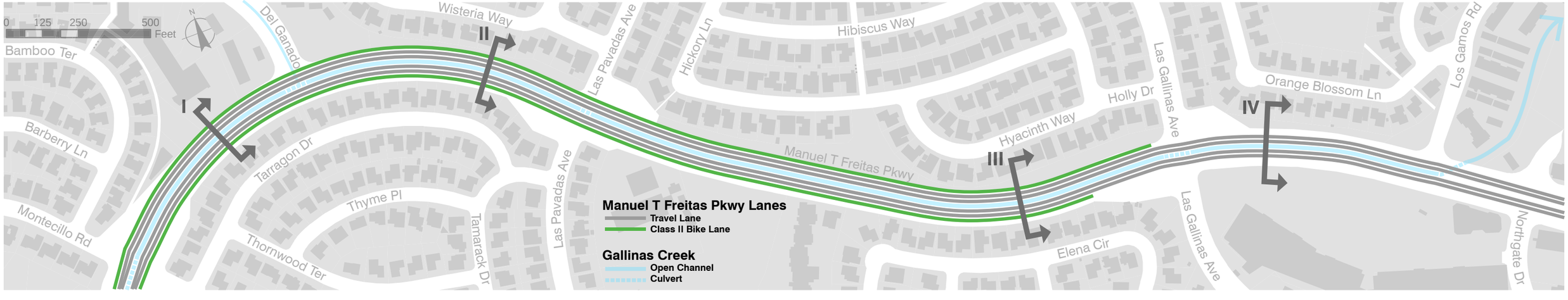
III - Las Pavadas to Las Gallinas



II - Del Ganado to Las Pavadas

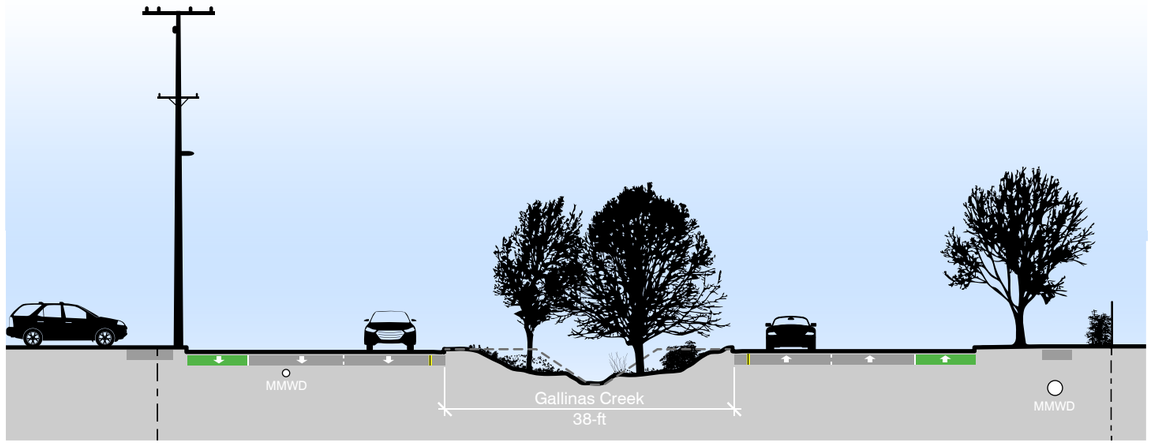


IV - Las Gallinas to Northgate Drive

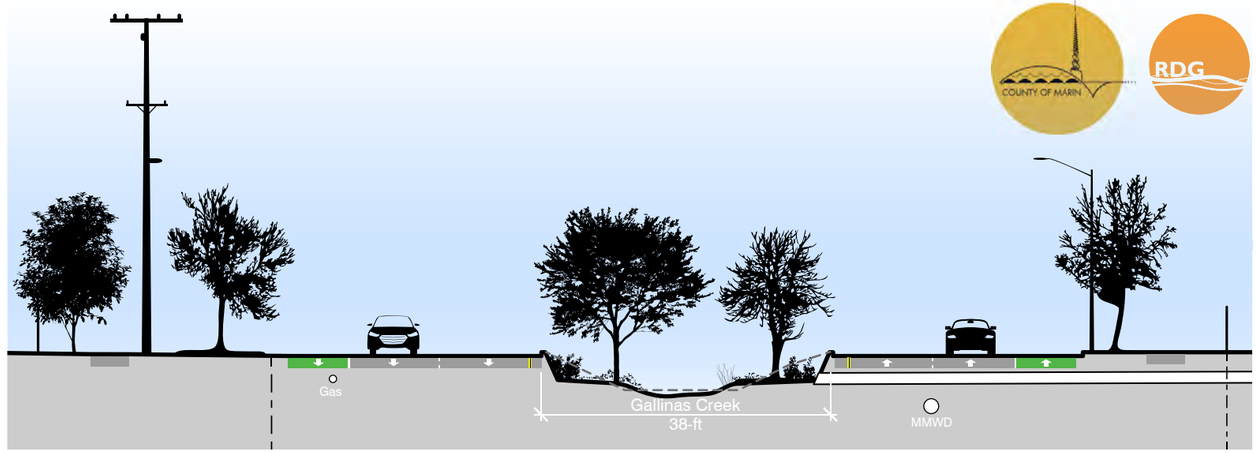


UPPER GALLINAS CREEK - Restoration Opportunities Assessment - *Existing Conditions*

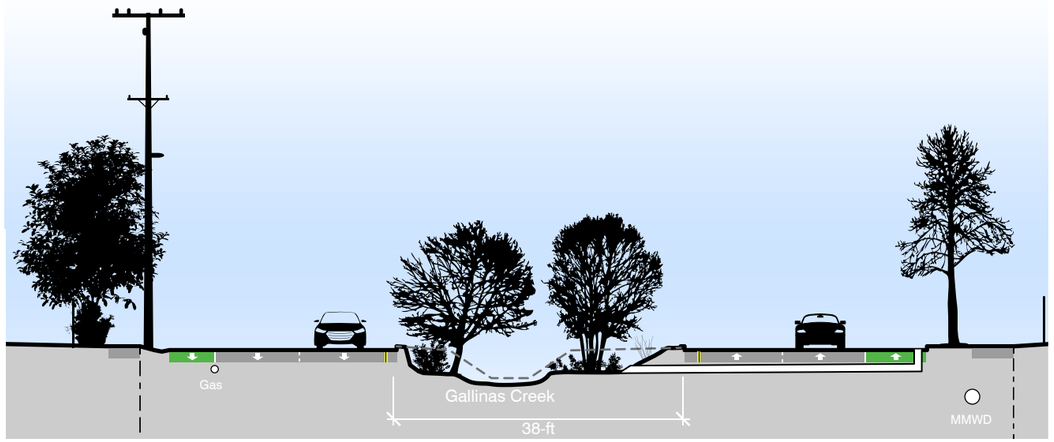
April 5, 2016



I - Montecillo to Del Ganado

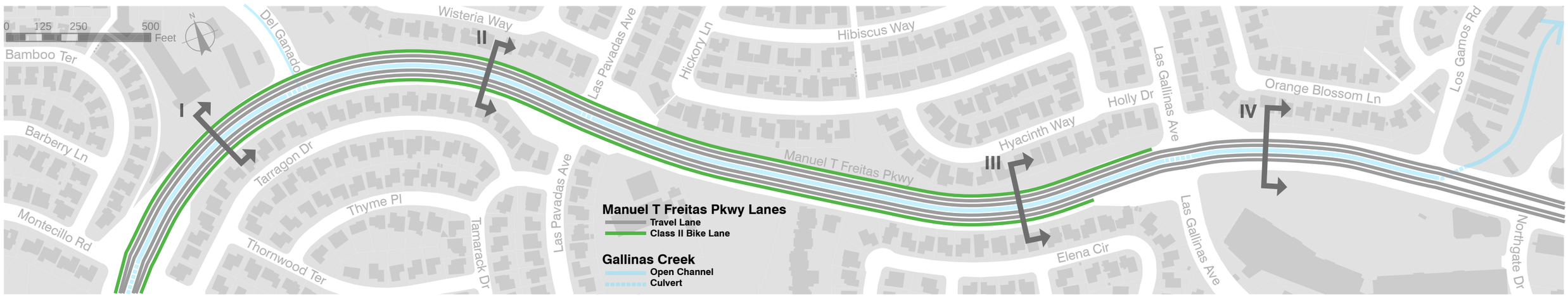


III - Las Pavadas to Las Gallinas



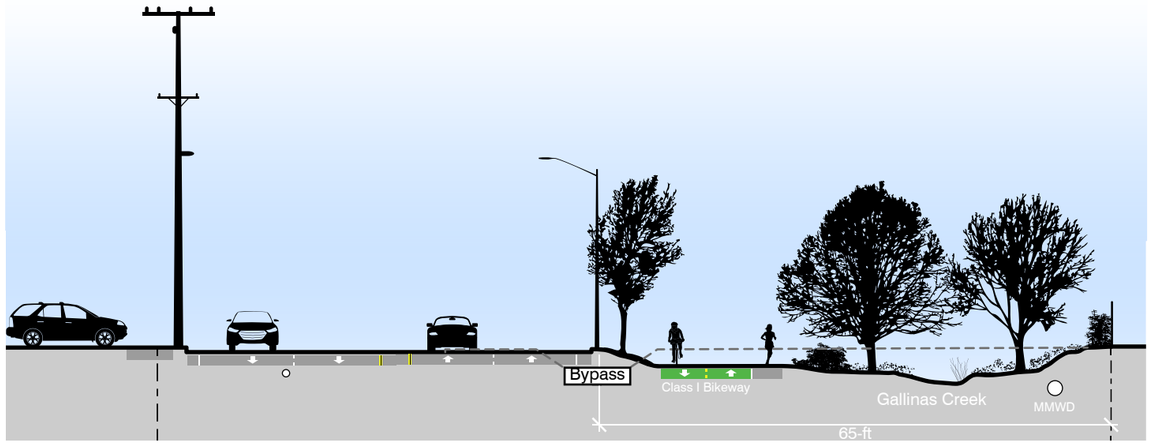
II - Del Ganado to Las Pavadas

IV - Las Gallinas to Northgate Drive

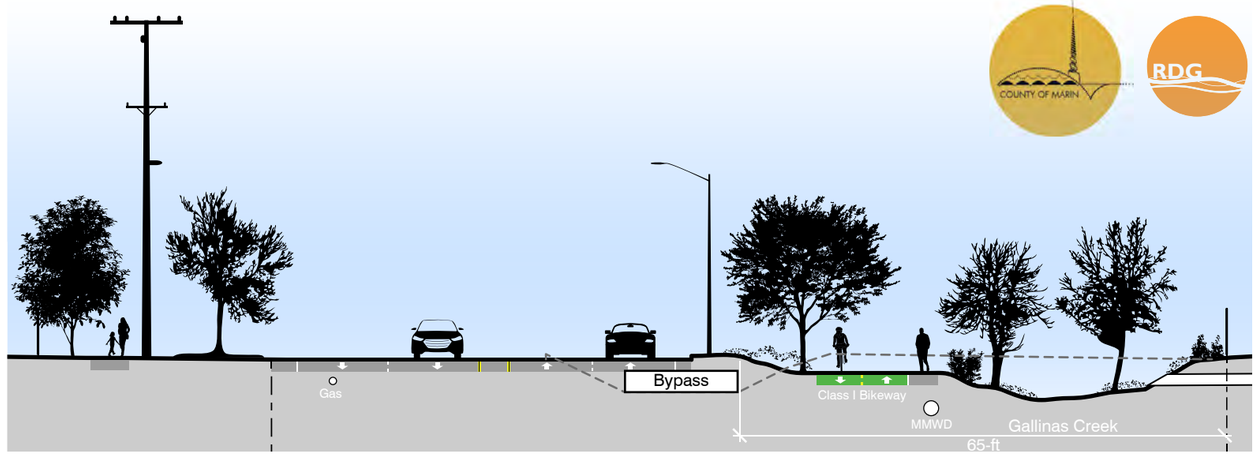


UPPER GALLINAS CREEK - Restoration Opportunities Assessment - *Alternate A - Restore in Place*

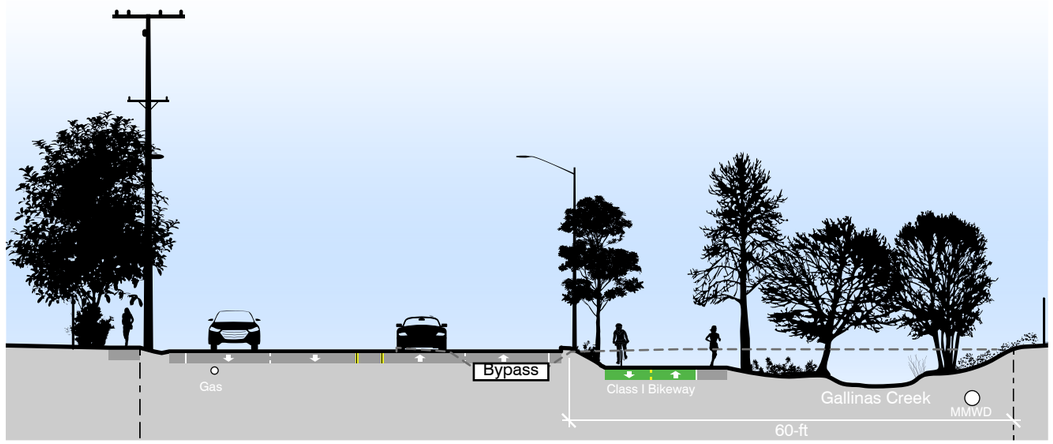
April 5, 2016



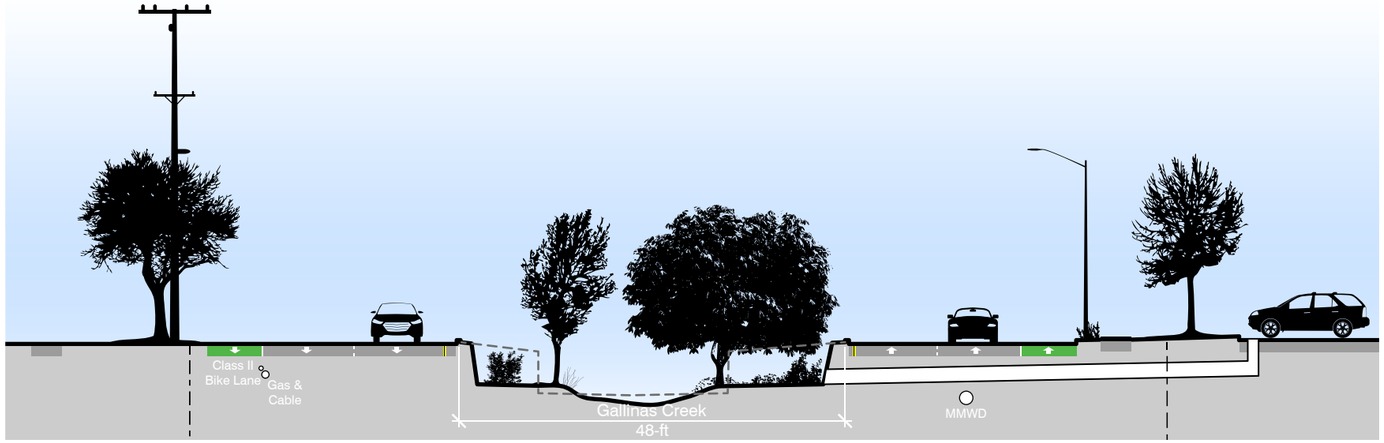
I - Montecillo to Del Ganado



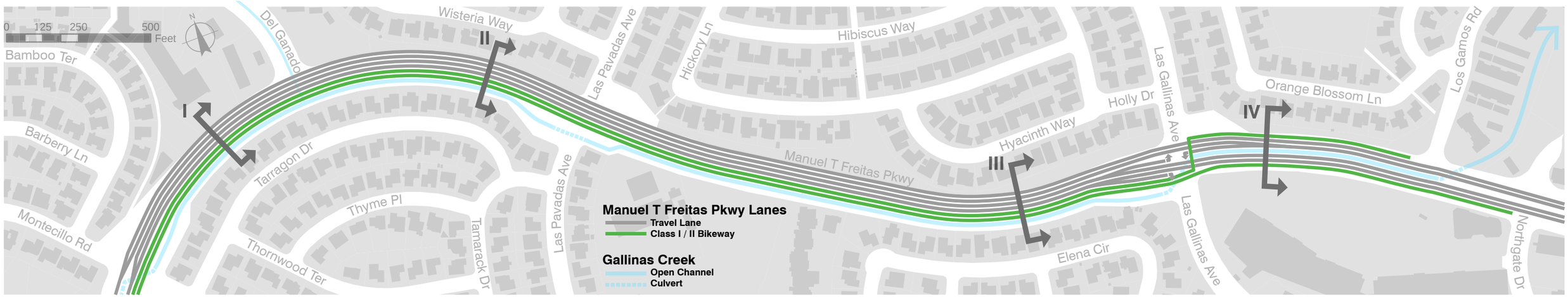
III - Las Pavadas to Las Gallinas



II - Del Ganado to Las Pavadas

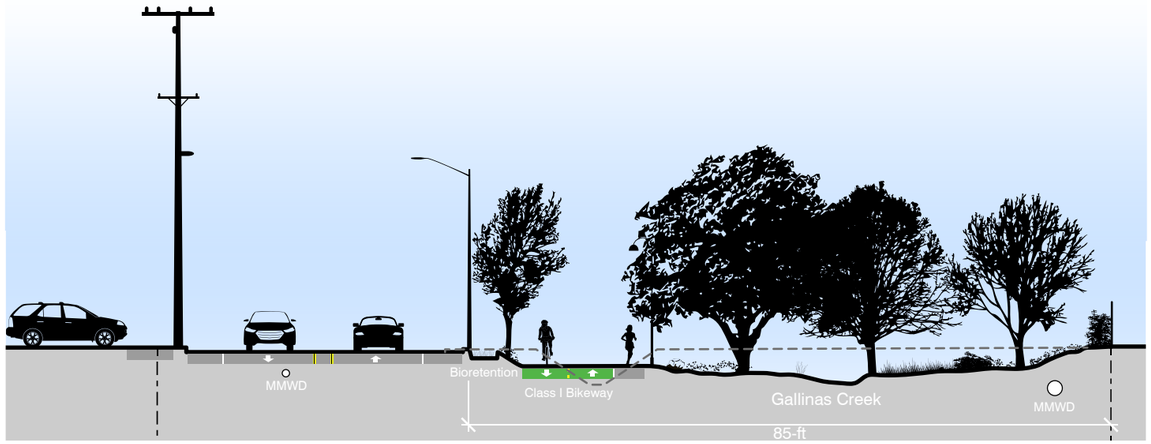


IV - Las Gallinas to Northgate Drive

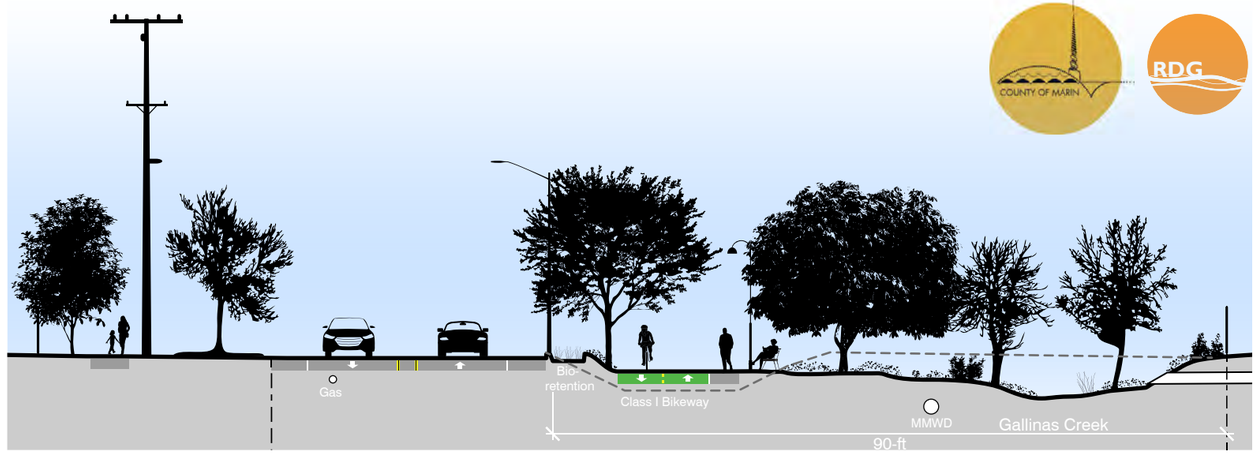


UPPER GALLINAS CREEK - Restoration Opportunities Assessment - *Alternate B - Restore with Greenway*

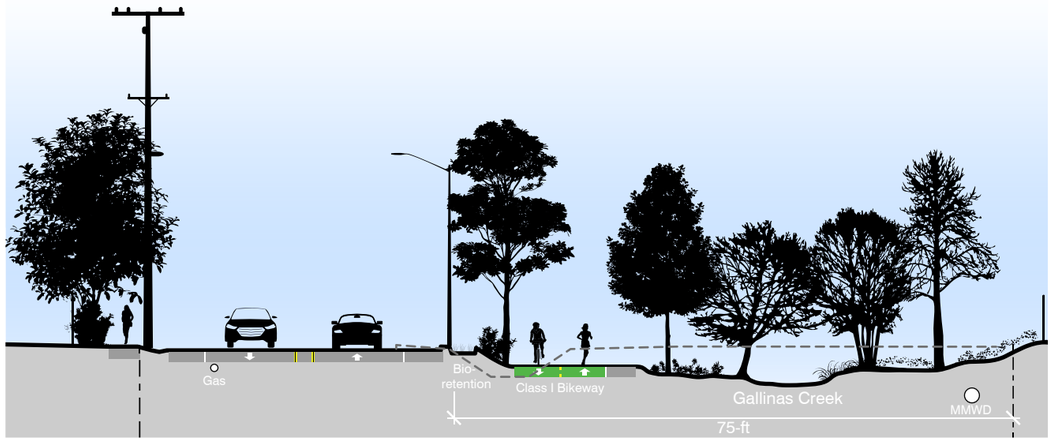
April 5, 2016



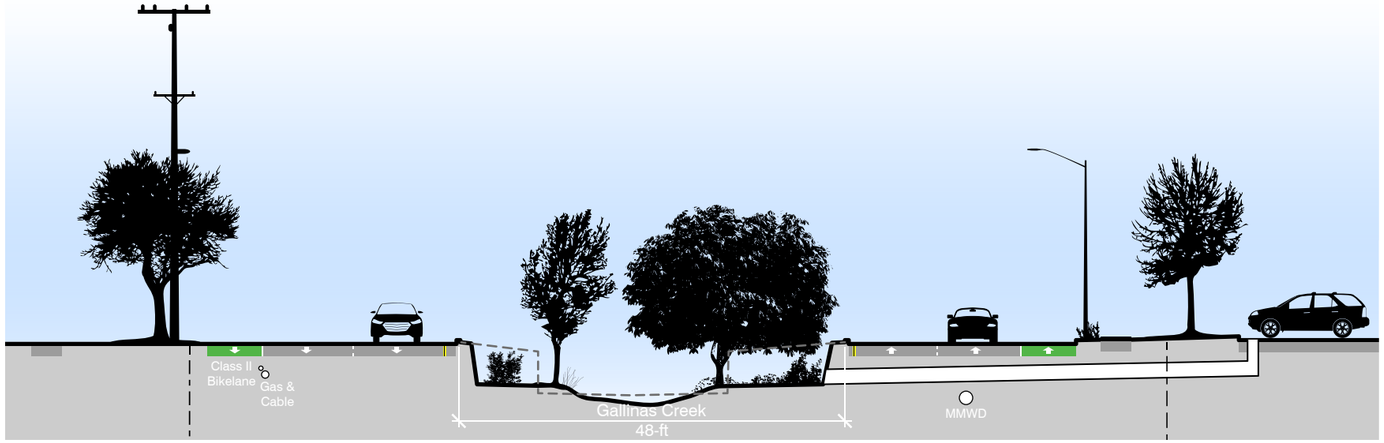
I - Montecillo to Del Ganado



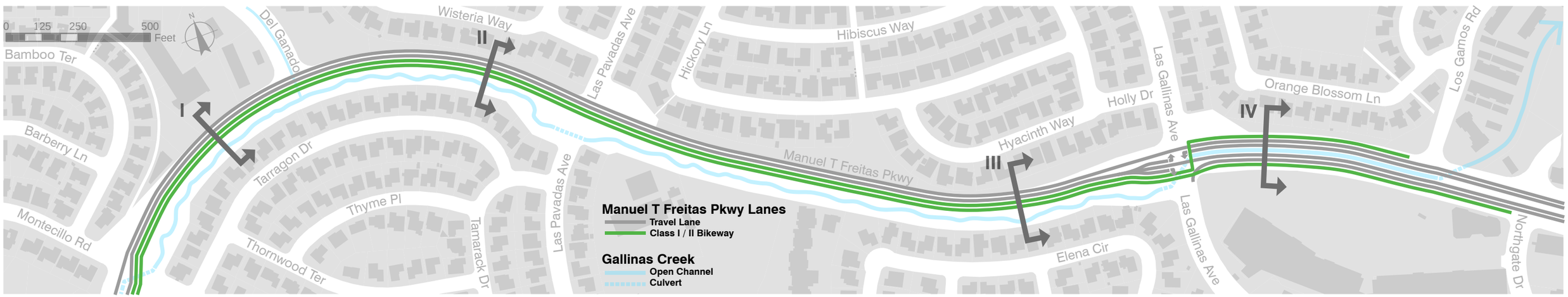
III - Las Pavadas to Las Gallinas



II - Del Ganado to Las Pavadas



IV - Las Gallinas to Northgate Drive



UPPER GALLINAS CREEK - Restoration Opportunities Assessment - *Alternate C - Full Restoration with Enhanced Greenway*

April 5, 2016