US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

DRAFT – APPENDIX I
VALUE ENGINEERING STUDY

September 2013

LOS ANGELES RIVER ECOSYSTEM RESTORATION

US Army Corps
of Engineers

VALUE ENGINEERING STUDY SUMMARY REPORT

PROJECT SPONSOR: THE LOS ANGELES DISTRICT

ARPIL 2013

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CONTROL NO: CESPL-13-02
VALUE ENGINEERING OFFICER: Arnecia Williams, AVS

Value Engineering Study on

Los Angeles River Ecosystem Restoration

Final 29 April 2013
U.S. Army Engineer District, Los Angeles

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PROJECT DESCRIPTION AND BACKGROUND

PROJECT TITLE:	Los Angeles River Ecosystem Restoration
PROJECT LOCATION:	Los Angeles, California

The U.S. Army Corps of Engineers (Corps) involvement with the LA River began after devastating floods destroyed homes, businesses, and infrastructure in the early 20th Century. The Corps then began examining options for flood risk management, which led to the channelization of the River in the 1930s and 1940s and the current concrete configuration. This configuration destroyed and drastically altered riparian and freshwater marsh habitats as well as ecosystem functions in the once natural river system. The flood control project also allowed for increased urbanization and development in the floodplain, further reducing the marsh and riparian habitats that had naturally occurred on the river and its tributaries. The Corps' involvement on the LA River continues today in sharing operation and maintenance responsibilities with the LA County Flood Control District.

The U.S. Congress directed the Corps to undertake the LA River Ecosystem Restoration Study in 2006. The Study initially focused on the first 32 miles of river, and was subsequently narrowed to focus on the 10-mile Study area (aka ARBOR reach), which exhibits the greatest potential for ecosystem restoration. This reach includes the "soft-bottomed" Glendale Narrows that connects Griffith Park to Downtown LA and that currently supports degraded riparian habitat. The soft bottomed reaches currently support a natural bed with concrete banks due to a high groundwater table that did not allow the bed to be constructed with concrete. In 2007, the City of LA adopted the long-range LA River Revitalization Master Plan that calls for the creation of a 64-mile network of trails, parks, and recreation along both sides of the first 32 miles of the LA River, from the San Fernando Valley to the City of LA's border with the City of Vernon, an area home to more than one million people. The entire Study area is within the Master Plan's focus area.

This value engineering study focused on the current state of design, and the aforementioned 10-mile Study area. Opportunities for increased value and decreased cost were investigated. Please see the CHAP Habitat Evaluation Appendix, Los Angeles River Ecosystem Restoration Study for further information.

VALUE ENGINEERING TEAM STUDY

EXECUTIVE SUMMARY

Value Engineering is a process used to study the functions a project is to provide. As a result, it takes a critical look at how these functions are met and develops alternative ways to achieve the same function while increasing the value of the project. In the end, it is hoped that the project will realize a reduction in cost, but adding value over reducing cost is the focus of VE.

The Value Engineering Study was initiated during the week of 25 to 29 March, 2013 at the Los Angeles District. The project was studied using the Corps of Engineers standard Value Engineering (VE) methodology, consisting of five phases:

Information Phase: The team studied drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved. Cost Models (see Appendix C) were compared to determine areas of relative high cost to ensure that the team focused on those parts of the project which offered the most potential for cost savings. The team visited the construction sites to gain knowledge of the area.

Speculation Phase: The Team speculated by conducting brainstorming sessions to generate ideas for alternative designs. All team members contributed ideas and critical analysis of the ideas was discouraged (see Appendix B).

Analysis Phase: Evaluation, testing and critical analysis of all ideas generated during speculation was performed to determine potential for savings and possibilities for risk. Ideas were ranked by priority for development. Ideas which did not survive critical analysis were deleted.

Development Phase: The priority ideas were developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches, technical support documentation, and cost estimates were prepared to support implementation of ideas. Additional VE Team Comments were included for items of interest which were not developed as proposals, and these comments follow the study proposals.

Presentation Phase: Presentation is a two-step process. The published VE Study Report is distributed for review by project supporters and decision makers. A briefing is later conducted to decide which proposals merit implementation into project design. The Summary of Proposals follows on the next page.

VALUE ENGINEERING TEAM STUDY
SUMMARY OF PROPOSALS

Seventy one ideas for ways to improve the projects or reduce costs were generated during the Speculation Phase of this study. The Analysis Phase of the study reduced the number of ideas to thirty six for development, of which twenty eight ideas were designated as design comments and are included in this report.

Of all the ideas from the Analysis and Development Phases, eight ideas became proposals which, when accepted, can result in the savings shown below. The idea that shows a negative number is not recommended.

PROPOSAL NO.	DESCRIPTION	SAVINGS
1	Develop Mass Balance for Materials	$19,597,000
2	Down Scale the Planter Boxes	$36,203,000
3	Use Pre-Cast Concrete Planters and/or Modularize Planters	$90,507,000
4	Modify the Terraces	$120,736,000
5	Use Random Material for Grade Control Structures Cores	$4,700,000
6	Use Sheet Pile Walls in Lieu of Concrete for Planter Boxes	-$861,625,000
7	Delete the Fences	$10,206,000
8	Use Wrought Iron Fence In Lieu of Chain-Link	$0

Disposition of Recommendations

Below are the VE recommendations, potential savings, and an explanation as to whether these recommendations are valid, and accepted or rejected. The decision to accept or reject a proposal is based on the technical, environmental, and cost feasibility of the proposal, as well as input from the PDT.

VE Study Recommendations:

Rec #	Description	Projected Savings	Comment
1	Develop Mass Balance for Materials	$19,597,000	Valid recommendation and conditionally accepted. Additional technical analysis during PED.
2	Down Scale the Planter Boxes	$36,203,000	Valid recommendation and conditionally accepted. Proposal not applicable for Reach 4.
3	Use Pre-Cast Concrete Planters and/or Modularize Planters	$90,507,000	Valid recommendation and conditionally accepted. Proposal not applicable for Reach 4. Additional technical analysis during PED.
4	Modify the Terraces	$120,736,000	Valid recommendation and conditionally accepted. Proposal not applicable for Reach 4. Additional technical analysis during PED.
5	Use Random Material for Grade Control Structures Cores	$4,700,000	Valid recommendation and conditionally accepted. Additional technical analysis during PED.
6	Use Sheet Pile Walls in Lieu of Concrete for Planter Boxes	-$861,625,000	Not valid and rejected due to extensive cost.
7	Delete the Fences	$10,206,000	Not valid and rejected due to safety concerns.
8	Use Wrought Iron Fence In Lieu of Chain-Link	$0	Valid recommendation and accepted.

TOTAL POTENTIAL CUMULATIVE SAVINGS: $ 281,949,000

TOTAL OF ACCEPTED/CONDITIONALLY ACCEPTED RECOMMENDATIONS = $ 271,743,000

TOTAL OF QUALITY IMPROVEMENT RECOMMENDATIONS = $0

DESCRIPTION: Develop Mass Balance for Materials

ORIGINAL DESIGN:

The original design calls for material from excavations to be hauled off site, and material for embankments to be hauled in.

PROPOSED DESIGN:

The proposed design is to create a "Mass Balance" of materials. This would be accomplished by using all excavated materials from the entire job as fill material in other locations in the project area.

ADVANTAGES:

- Faster construction.
- Reduced cost.
- Less wear and tear on local roads and streets.
- More environmentally friendly.
- Less soil testing.

DISADVANTAGES:

- Slight decrease in quality of some embankments.

JUSTIFICATION:

From the unit costs available, the cost for material hauled off site is $28.50 per cubic yard. The cost for compacted fill is $33.50. These costs go down if the material is kept on site. From the estimate if only 15% is hauled off and replaced the cost drops to $7.00 and $13.00 per cubic yard respectively. For purposes of this proposal, it was assumed that an additional 10%, or 25% of the total of the required cut could be used or wasted on site. This results in a savings of $21.50 for excavation and $20.50 for embankment. This could be accomplishable since the fills are not part of critical structure where settlement and instability are an issue. The following spreadsheet presents the data by reach.

COST ESTIMATE WORKSHEET

DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Reach 1 Excavation	CY	359,700		$0
Reach 1 Embankment	CY	88,952		$0
Reach 2 Excavation	CY	30,000		$0
Reach 2 Embankment	CY	0		$0
Reach 3 Excavation	CY	117,685		$0
Reach 3 Embankment	CY	0		$0
Reach 3 Excavation	CY	1,524,592		$0
Reach 3 Embankment	CY	0		$0
Reach 4 Excavation	CY	133,711		$0
Reach 4 Embankment	CY	0		$0
Reach 5 Excavation	CY	94,065		$0
Reach 5 Embankment	CY	42,289		$0
Reach 6 Excavation	CY	1,463,100		$0
Reach 6 Embankment	CY	0		$0
Reach 7 Excavation	CY	918,331		$0
Reach 7 Embankment	CY	0		$0
Reach 8 Excavation	CY	1,886,602		$0
Reach 8 Embankment	CY	0		$0
				$0
Total Excavation Hauled Off	CY	6,527,786		$0
Total Embankment Hauled In	CY	131,241		$0
Excess Material	CY	6,396,545		$0
				$0
Assumed an additional 10% Remains on Site	CY	639,655	$21.50	$13,752,572
				$0
				$0
		Total Deletions		$13,752,572
ADDITIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
None				$0
				$0
		Total Additions		$0
		Net Cost Decrease		$13,752,572
		Mark-ups	42.50%	$5,844,843
		Total Cost Decrease		$19,597,415

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 PAGE NO: 1 OF 2

DESCRIPTION: Down Scale the Planter Boxes

ORIGINAL DESIGN:

The current design calls for 158,784 Cubic Yards of steel reinforce planter boxes.

PROPOSED DESIGN:

The proposed design is to downsize the planter box features, as the team identified it as a high cost item.

ADVANTAGES:

- Reduce cost.
- Faster construction.

DISADVANTAGES:

- Reduced scope.

JUSTIFICATION:

The following spreadsheet shows that a modest decrease in planter boxes of 20% would result in a substantial savings, while at the same time providing most of the project value. However, this is a decrease in scope. If this modest decrease can fulfill the project purpose it is recommended. This would be accomplished in final design by optimizing the planter box location.

COST ESTIMATE WORKSHEET				
DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Concrete Planters				$0
Reach 4	CY	119253		$0
Reach 5	CY	29187		$0
Reach 8	CY	10344		$0
				$0
Concrete Planters 20% Reduction				$0
Reach 4	CY	23850.6	$800.00	$19,080,480
Reach 5	CY	5837.4	$800.00	$4,669,920
Reach 8	CY	2068.8	$800.00	$1,655,040
				$0
				$0
				$0
		Total Deletions		$25,405,440
ADDITIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$0
		Net Cost Decrease		$25,405,440
		Mark-ups	42.50%	$10,797,312
		Total Cost Decrease		$36,202,752

DESCRIPTION: Use Pre-Cast Concrete Planters and/or Modularize Planters

ORIGINAL DESIGN:

The original design utilizes 158,794 cubic yards of concrete planters which would be cast on site. Planters are integrated as ecosystem restoration features through use of riparian vegetation to provide edge habitat adjacent to the river.

PROPOSED DESIGN:

The Proposed design is to incorporate either individual or modular pre-cast concrete planters in lieu of custom-fit planters cast at the site.

ADVANTAGES:

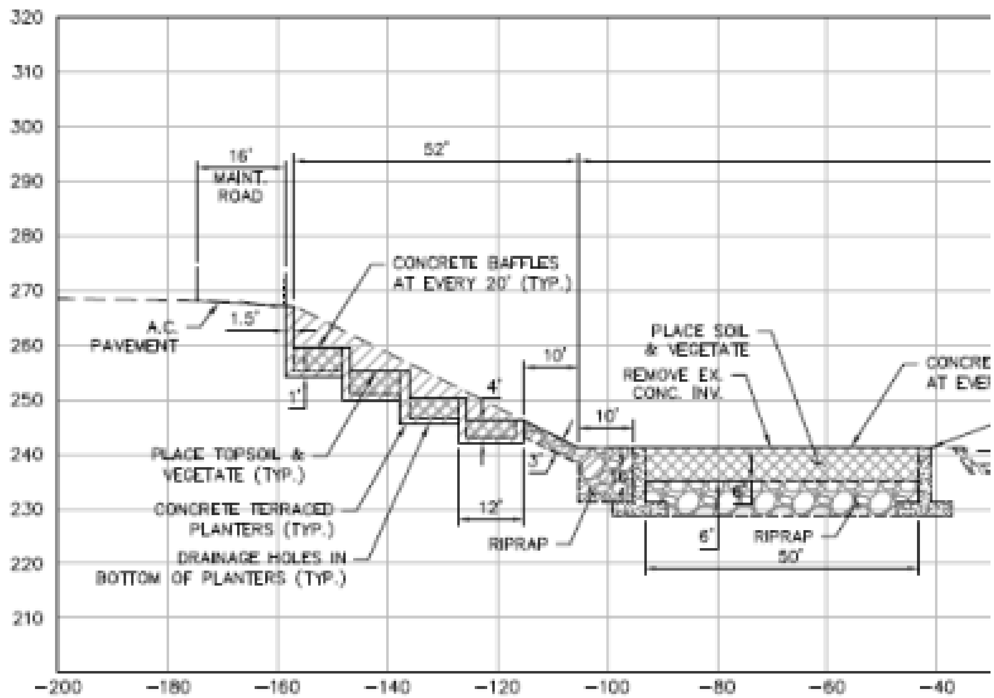
- Reduces cost while maintaining functionality.
- Quick turnaround and reduced cycle time
- Meets International Building Code requirements
- Durability

DISADVANTAGES:

- Would not provide custom fit of the planters to the site.

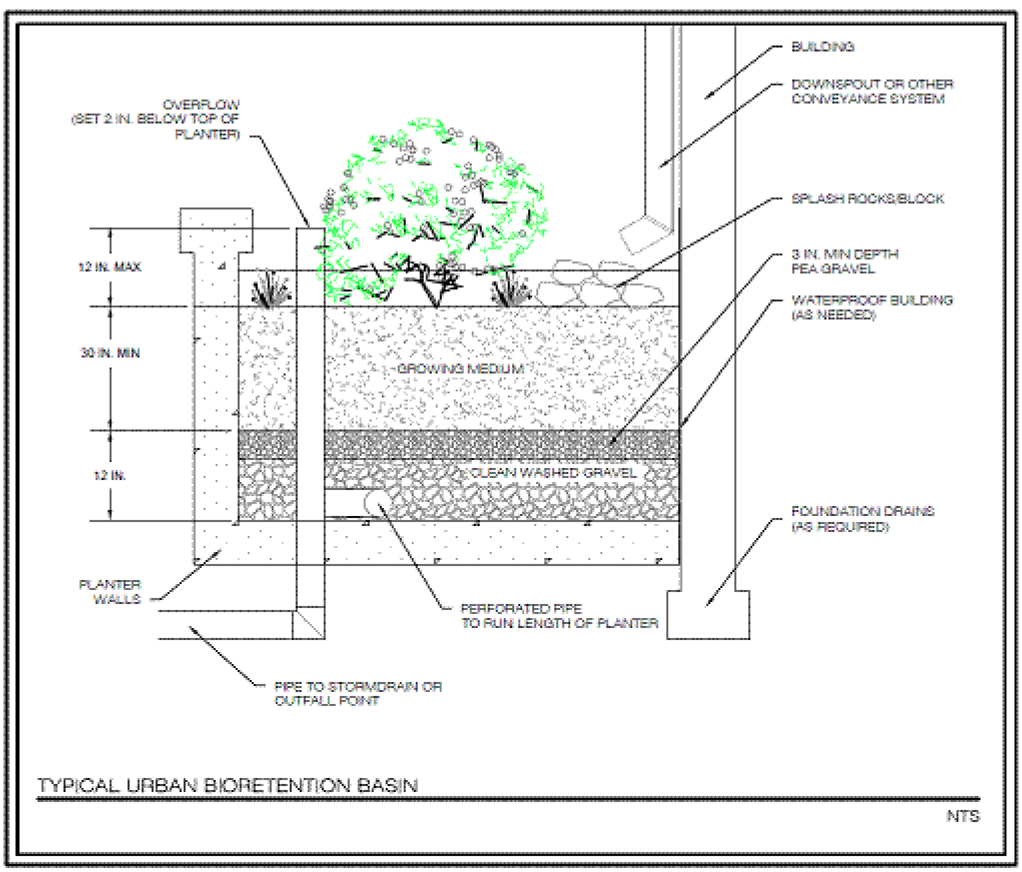
JUSTIFICATION:

Using modular pre-cast concrete planters will reduce the cost of using custom planters while maintaining functionality. Using precast concrete planters provide for a quicker turnaround. It allows for the ability to begin casting components for the superstructure while foundation work is in progress. Precast concrete components can also be cast and erected year-round, without delays caused by harsh weather. Additionally, the new systems have a variety of textures, colors, finishes and inset options that can be used.



Concrete planter cross-section

Examples of pre-cast concrete planters



COST ESTIMATE WORKSHEET				
DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Concrete Planter Boxes	CY	158,784	$800.00	$127,027,200
Assume 2 CY per planter Box				$0
79392 Planter Boxes				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Deletions		$127,027,200
ADDITIONS				
	UNITS	QUANTITY	UNIT COST	TOTAL
Concrete Planter Boxes	CY	158,784	$400.00	$63,513,600
Assume 2 CY per planter Box				$0
79392 Planter Boxes				$0
and a reduction to $500 per Cubic Yard				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$63,513,600
		Net Cost Decrease		$63,513,600
		Mark-ups	42.50%	$26,993,280
		Total Cost Decrease		$90,506,880

DESCRIPTION: Modify the Terraces

ORIGINAL DESIGN:

Terraces are incorporated throughout each reach to reduce the angularity of the trapezoidal channel, serve as a medium for vegetative restoration and provide public access points to the river. Terraces require demolition of the existing channel surface, change to the channel geometry and reconstruction through the use of concrete planters and surface walkways.

PROPOSED DESIGN:

The proposed design is to reduce the scale of the terraces by 33% to achieve cost savings for the project.

ADVANTAGES:

- Reduces the total project costs and footprint of impact.

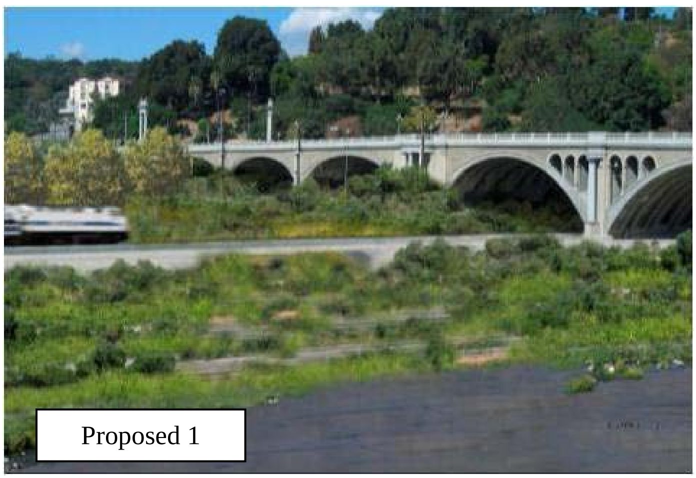
DISADVANTAGES:

- May reduce the overall benefits of the project. The PDT will need to evaluate which areas may be suitable candidates based on a cost-benefit analysis of the effects of the terraces.

JUSTIFICATION:

Terraces compose a significant portion of the total project costs. Reduction in the scale of the terraces may be able to be achieved while maintaining high priority ecosystem restoration areas.


Current Condition


Proposed 1


Proposed 2

Examples of terraces with existing and proposed conditions. Proposed condition 1 will maximize the vegetation on the terraces and proposed condition 2 allows for minimum vegetation.

COST ESTIMATE WORKSHEET

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Concrete Planter Boxes	CY	158,784	$800.00	$127,027,200
Assume 2 CY per planter Box				$0
79392 Planter Boxes				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Deletions		$127,027,200

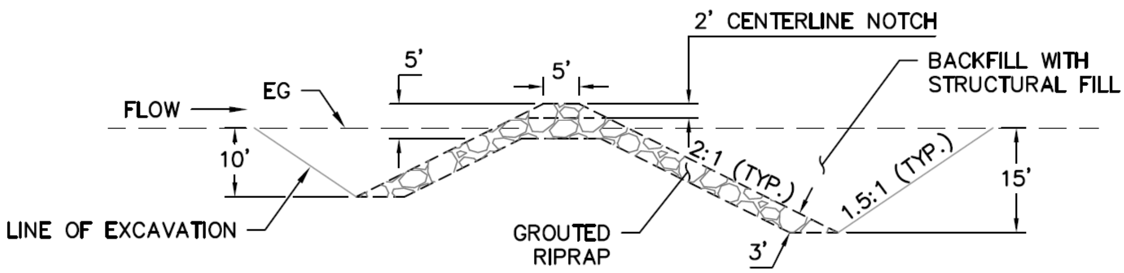
ADDITIONS

	UNITS	QUANTITY	UNIT COST	TOTAL
Assumes a 33% reduction	CY	105,750	$400.00	$42,300,058
in quantity				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$42,300,058
		Net Cost Decrease		$84,727,142
		Mark-ups	42.50%	$36,009,036
		Total Cost Decrease		$120,736,178

DESCRIPTION: Use Random Material for Grade Control Structures Cores

ORIGINAL DESIGN:

The original design calls for grouted rip-rap grade control structures with a compacted fill core.



GRADE CONTROL STRUCTURE DETAIL
NTS

PROPOSED DESIGN:

The proposed design calls for a random fill core. From the available data the quantities and units costs were derived. A 25% reduction in the cost of the core fill was assumed.

ADVANTAGES:

- Reduce cost.
- Faster construction.

DISADVANTAGES:

- Reduced scope.

JUSTIFICATION:

The following spreadsheet shows a modest decrease in core material costs, if a random material is used. This would result in a savings, while at the same time providing most of the project value. However, this is a small decrease in scope. If this modest decrease can fulfill the project purpose it is recommended. This would be accomplished in final design by optimizing the core fill.

DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Total Compacted Fill	CY	1,552,056		$0
				$0
25% of Total Compacted Fill	CY	388,014	$21.50	$8,342,301
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Deletions		$8,342,301
ADDITIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
				$0
25% of Total Compacted Fill	CY	388,014	$13.00	$5,044,182
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$5,044,182
		Net Cost Decrease		$3,298,119
		Mark-ups	42.50%	$1,401,701
		Total Cost Decrease		$4,699,820

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 6 PAGE NO: 1 OF 2

DESCRIPTION: Use Sheet Pile Walls in Lieu of Concrete for Planter Boxes

ORIGINAL DESIGN:

The original design calls for steel reinforced concrete planter boxes.

PROPOSED DESIGN:

The proposed design calls for sheet pile cells.

ADVANTAGES:

- None.

DISADVANTAGES:

- Increase cost.

JUSTIFICATION:

The assumption that follows is that a 2 CY concrete planter box would be replaced by a sheet pile cell. The assumption was a PZ 27 with 3 feet exposed and 9 feet driven. As is shown on the following spreadsheet the cost is much higher and this proposal is not recommended.

COST ESTIMATE WORKSHEET				
DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Concrete Planter Boxes	CY	158,784	$800.00	$127,027,200
Assume 2 CY per planter Box				$0
79392 Planter Boxes				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Deletions		$127,027,200
ADDITIONS				
	UNITS	QUANTITY	UNIT COST	TOTAL
Sheet Pile (PZ 27) 12' Stick 3 Up 9 Down				$0
288 Face Feet per Box				$0
79392 Planter Boxes				$0
Sheet Pile (PZ 27) 12' Stick 3 Up 9 Down	SF	22,864,896	$32.00	$731,676,672
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$731,676,672
		Net Cost Decrease		-$604,649,472
		Mark-ups	42.50%	-$256,976,026
		Total Cost Decrease		-$861,625,498

DESCRIPTION: Delete the Fences

ORIGINAL DESIGN:

The original design utilizes 239,000 linear feet of chain-link fence to protect sensitive restoration areas, manage public traffic and improve site safety.

PROPOSED DESIGN:

The proposed design is to remove 100% of the fences proposed for the eight major reaches, but maintain fencing within tributary areas.

ADVANTAGES:

- Reduces overall costs.
- Increases aesthetics of viewscape.
- Promotes ecosystem connectivity.

DISADVANTAGES:

- Elimination of fencing would result in loss of protection of a large portion of the project footprint and may have public safety impacts.

JUSTIFICATION:

Cost reduction only.

COST ESTIMATE WORKSHEET				
DELETIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Chain Link Fence	LF	238,732	$30.00	$7,161,960
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Deletions		$7,161,960
ADDITIONS				
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
		Total Additions		$0
		Net Cost Decrease		$7,161,960
		Mark-ups	42.50%	$3,043,833
		Total Cost Decrease		$10,205,793

DESCRIPTION: Use Wrought Iron Fence In Lieu of Chain-Link

ORIGINAL DESIGN:

The original design utilizes 239,000 linear feet of chain-link fence to protect sensitive restoration areas, manage public traffic and improve site safety.

PROPOSED DESIGN:

The proposed design is to reduce the quantity of chain-link fence by 86% and replace with wrought iron fence.

ADVANTAGES:

- Improves aesthetics and durability.
- Reduces vandalism.
- Increases long-term reliability of protection.

DISADVANTAGES:

- Significantly more expensive. Would require reduction in quantity in order to remain cost-neutral.
- Reductions in quantities would result in loss of protection of a large portion of the project footprint.

JUSTIFICATION:

In order to remain cost-neutral, an 86% reduction would need to occur in the linear feet of fence proposed for the project. This would result in reducing the fence footprint from 239,000 linear feet to 32,500 linear feet. Locations for elimination of fencing would need to be undertaken by the PDT. Since this is a neutral cost with no change, no cost sheet is shown.

Example of 6' chain-link fence

Example of wrought-iron fence

1. ***Redesign the Terraces*** The terraces should accommodate plantings and wildlife passage to and from the channel bottom. Consider designing fences with fewer steps, and potentially incorporate an access path that can accommodate people and maintenance vehicles also. Terraces are an important feature for wildlife mobility in and out of the river. They are also beneficial to human access and enjoyment. The form terraces take can be varied and differ at different places in the project area. Whereas the costs were estimated with a design including a certain number of terraces, fewer, larger steps could be utilized.

2. ***Acquire More Land*** To maximize value (i.e. increase habitat units per cost to project), an effective way would be to add land to the project area under the following conditions:

- The land is adjacent to a site of restoration already in the project.
- The presumed restoration would be similar to or the same as the adjacent restoration, so it could be treated as an expansion of the existing area.
- No significant landscape/ excavation would be needed.
- The acquisition cost would be low compared to the other areas.

Under these conditions, ad expansion of planned restoration areas would be valuable, in an increase in total cost.

3. ***Recycle Existing Concrete.*** Concrete that is removed from the LA River channel and adjacent infrastructure should be recycled and/or incorporated into the new ecosystem restoration project. The recycled concrete can be used in other capacities and to reduce concrete cost, e.g. as fill or aggregate.

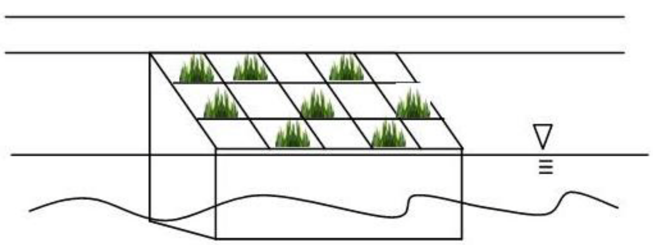
4. ***Recycle All Hard Material.*** All hard material (steel, concrete, etc) that is removed with the construction of the new project should be recycled with a preference of re-using the materials. Additionally the reduced cost associated with hauling and disposing of these materials from the demolition of previous structures is a benefit.

5. ***Increase Vehicular Access*** Adding access for motorized vehicles provides for a multiple-use function. Currently the LA River only has two access points. This will allow for the community to have several access points for entering the channel as well as habitat connectivity. Balance the popular use of using motorized vehicles and having it done in an environmentally-sensitive way.

6. ***Increase Shade.*** Where possible, design pathways, viewing towers, and other project elements to create shaded spots to aid in habitat establishment and health. For example, (a) cantilever paths, (b) design towers with awnings, and (c) create boulder-based refuge areas in the channel.

7. ***Use Differently Armored Banks.*** Instead of terraces at some places, or to replace grouted riprap slopes, or where geo-engineered banks are infeasible, use an armored bank that will allow vegetation to grow in gaps. This could be a concrete "egg carton" inset into the bank or box concrete storm culverts could be repurposed and inset vertically to create a structural slope with infill that is vegetated. This could present a significant cost saving to cast-in-place boxes while offering some habitat.

Illustration Provided



8. ***Add Viewing Stations.*** Viewing stations can be used to monitor how geomorphology is performing over time, can aid in habitat and wildlife health evaluation, can provide public educational value, and can keep people away from direct interference in habitat areas. They may also be able to provide bird perches and/or bat habitat and their bases could support vegetation such as vines.

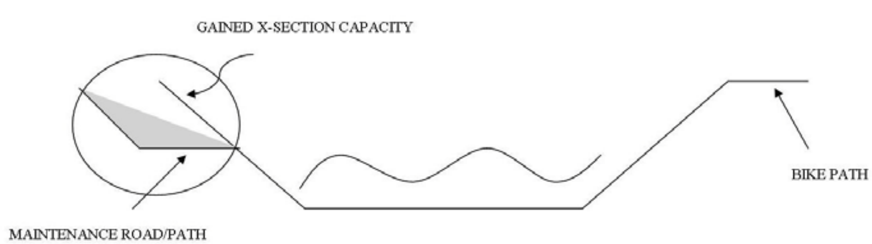
9. ***Creatively Finance Across Corp Mission.*** Acknowledge if it may be possible to consolidate Corps investments in O&M, ecosystem, recreation and/or flood protection if a project's implementation can be shown to affect or be impacted by each. For example, O&M has been historically underfunded and new ecosystem and recreation funds will be needed. Could the aggregate needs/requests in the separate accounts be reduced if a blended investment is made with reduced transaction costs associated with the overhead, administration, etc in the 3 separate bureaucratic channels? This could be a 'special case' applicable only to urban cases recognized as Urban Waters Federal Partnership pilots by the Obama administration (there are seven (7) and USACE is a partner agency of this).

10. ***Use Adjacent Areas for Any Mitigation.*** When and where feasible, given that adjacent land acquisition is critical – consider using lands that will be needed for future phases of the project for staging, storage, etc, thereby acquiring those for future ecosystem use. For example, to avoid long hauls to distant places (an air quality problem) or dumping of materials in distant landfills (expensive and accumulative/climate change impacts) store materials on nearby parcel, recycle them, break them up, etc. to reuse them (cap or cover lay soil as part of geomorphology is landscape). This way lands are acquired for staging, construction but reused as ecosystem areas and result in acquisition mitigation, etc.

11. ***Allow Natural Sedimentation to Act as Fill.*** Allowing natural sedimentation processes to establish islands and banks in certain areas would save costs of fill importing and placement, and would allow the river to form a more natural geomorphology. This may be especially appropriate at the areas of major channel reconfiguration like Verdugo Wash Confluence, Taylor Yard, and Piggybank Yard. For instance at Taylor Yard, if modular concrete armoring sheet curves were placed in the bed of the river and allowed to catch debris and sediment, then the deposits would form in a more natural way. Additionally, the process would be studied by local researchers for future optimization.

12. ***Increase Capacity by Lowering Maintenance Roads.*** In strategic places it may make sense to change the location of the maintenance roads and notch it into the channel (see illustration). This would be most beneficial where we know there is a chance of break-out during a rare rain event, or the maintenance part is wide enough at the top to still accommodate emergency access during rain even, or there would be little impact to existing structures at the top of the bank. The road should be placed at the level of storm event for optimized access (say 20% storm). The excess capacity could offset increase vegetation (roughness) elsewhere in the channel.

Illustration provided



13. ***Build One Small Area First, as an Example.*** Construct a portion of the total project first, showcasing what is possible and what will work well in a given area or reach. This may be useful if only partial funding is available and sequencing construction (based on a small area) is more feasible at the time. Also, the entire project may need to be constructed in smaller pieces overtime as funding and resources are allocated. This project area can act as a pilot for the overall larger project and offer solutions for future design and engineering challenges.

14. ***Build the Most Intensive Areas First.*** By sequencing or phasing construction strategically, and building the largest most intense areas first, the most ecological value would be realized earlier. This could be considered during the completion of the feasibility report.

15. ***Use Strategic Maintenance Methods.*** Do invasive plant/vegetation work upstream in the LA River and tributaries first, and then work in project area. This will maximize performance of the overall project. Due to seed transport, it is highly likely that seeds from invasives will re-plant themselves in the project area, if they are not managed upstream from the project area.

16. ***Establish Plant Harvesting Area.*** The construction of the recommended project will be done in phases over several years, and there is a significant amount of vegetation and trees that will be installed. These will be specific native species. It may be possible to save money be having an initial phase of the project include establishing a nursery of plant farm that will be used by the rest of the project. For example, if the Taylor Yard area was started right away with the trees that will be needed in 10 years at Piggyback, then the cost of buying mature trees in 10 years is eliminated or reduced and replaced with the cost of nurturing the trees, which may be lower. This offers a significant aesthetic and ecosystem benefits as well by establishing mature plants in restoration areas. This could also be done with bushes and other plants.

17. ***Increase In-Channel Vegetation***. Focusing on increasing in-channel vegetation, in part at the expense of the terrace/bank vegetation will increase the value of the habitat created since the riparian vegetation will be closer to the water. In combination with focusing on the primary areas for connectivity to the mountains (item 54), will increase the functionality of the riparian areas. Focusing on maintaining and improving in-channel vegetation will reduce O&M costs due to the reduction in watering required.

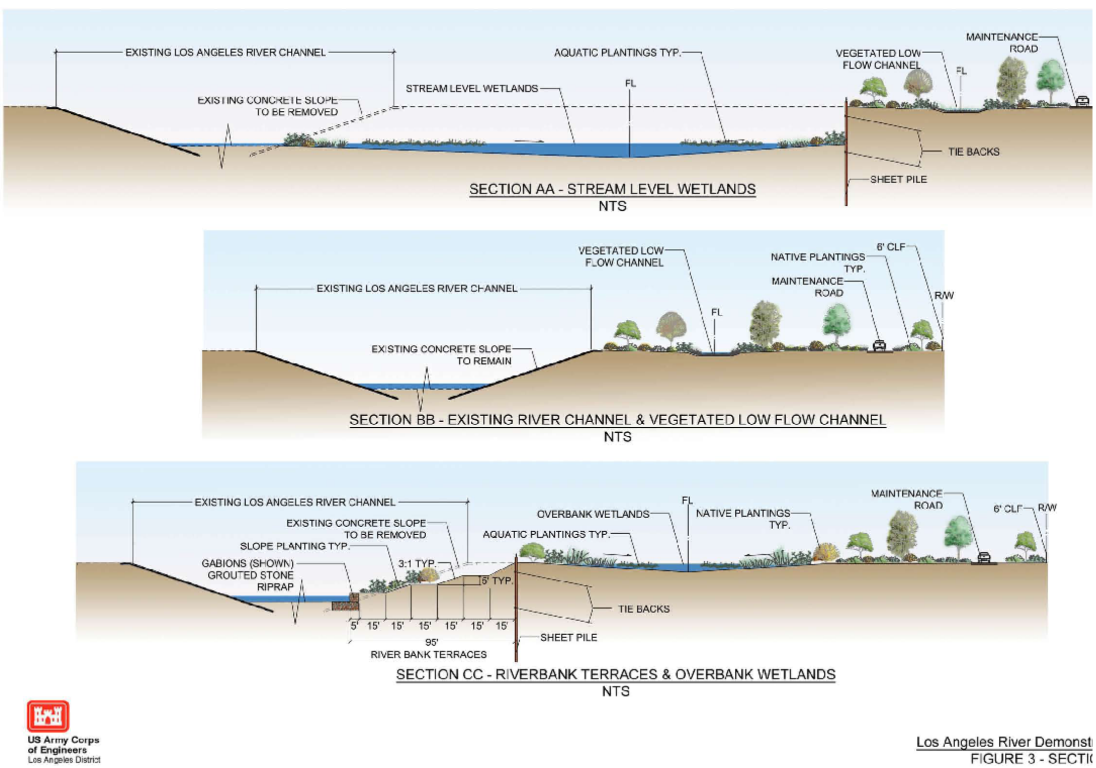
18. ***<u>Use Different Armoring Techniques</u>***. While the traditional bank protection method for the Los Angeles River has been a concrete lined trapezoidal channel, this technique has become outdated and carries with it significant environmental impacts. Especially in areas where levees are not present, an examination of alternative bank protection methods should be evaluated. As long as a significant toe is established, riprap or other structures could be used in various locations on the project alignment. As one progresses further up the bank and velocities drop, the integration of vegetation with the protection can be accomplished to increase environmental benefits.

19. ***<u>Prioritize Projects with Connectivity to Santa Monica and San Gabriel Mountains</u>***. Because the project is focusing on establishing the "bones" of the ecosystem which can be built upon via other restoration projects, emphasis/priority should be placed on first building the projects which will establish connectivity to the Santa Monica and San Gabriel Mountains. Establishing these connections first will allow for increased wildlife usage of the riparian areas.

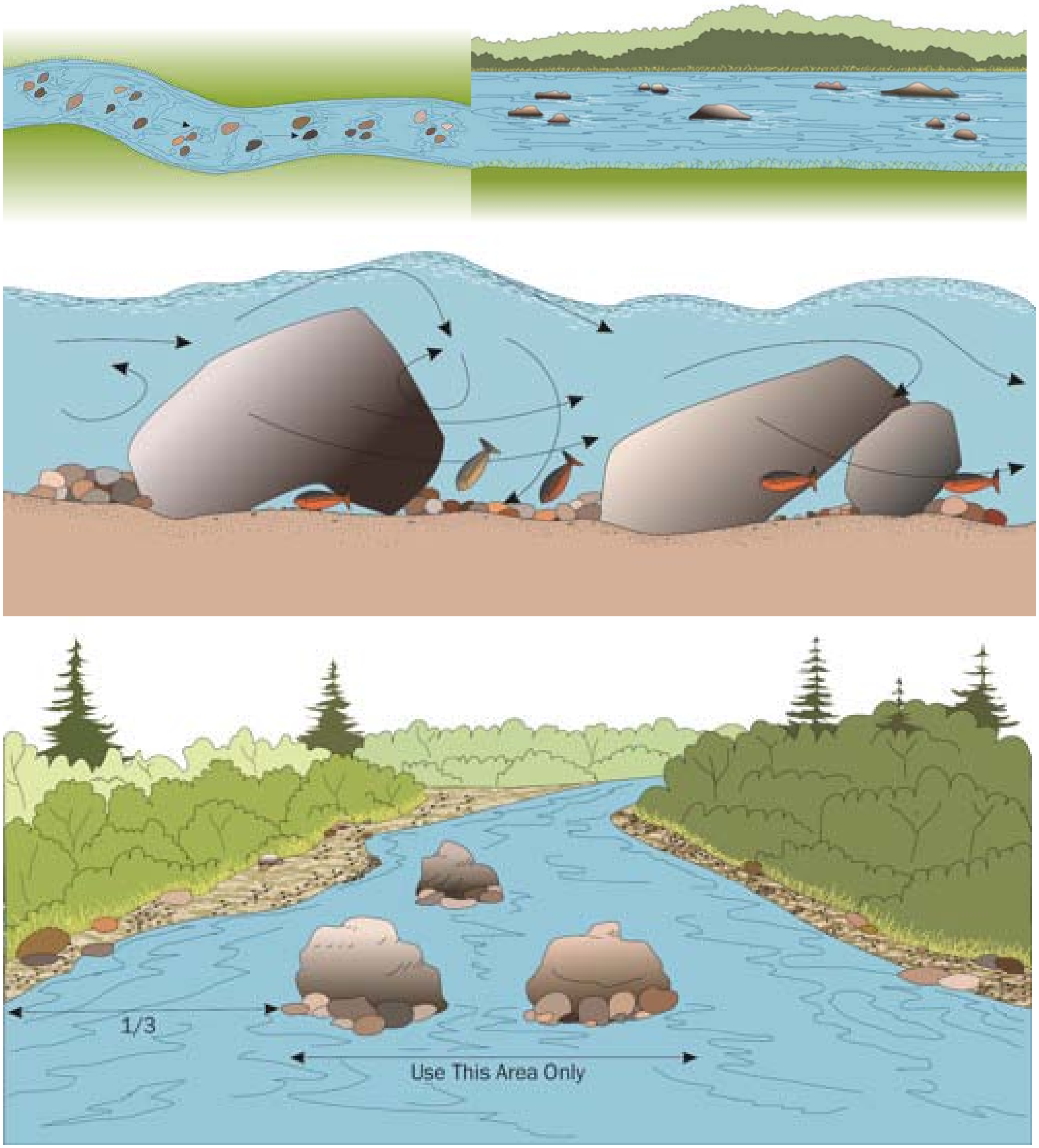
20. ***<u>Reevaluate Roughness Coefficient</u>***. The values used for vegetation roughness in the hydraulic analysis should be reevaluated. Researchers at ERDC (Fischenich and Derrick) have additional information that could be used in adjusting the Manning's N for vegetation. A decrease in Manning's N could significantly change project design as well as increase project benefits due to increased planting of vegetation and reduction in maintenance costs and frequency while at the same time maintaining the existing level of protection.

21. ***<u>Increase Channel Complexity.</u>*** The VE team suggested that the project increase the channel complexity. Some ideas are as follows:
Restore freshwater marsh areas at the confluence of the main stem of the LA River and tributaries such as Burbank Channel, Verdugo Wash and Arroyo Seco.
Incorporate boulder fields in bottom of channel through the marsh areas to provide in-stream habitat refuge and resting areas for aquatic species. Boulders provide velocity breaks during high flows to disperse energy and allow for refuge areas for aquatic species. Boulder fields may mobilize during high flows and will require evaluation. Integration of channel complexity into the marsh design will require consideration of maintenance for replacement of lost material. Addition of boulder fields will increase project benefits at minimal cost.

Example side channel with freshwater marsh through golf course



Cross-section examples of freshwater marsh areas



Conceptual diagrams of in-stream boulder placement

22. ***Use Vegetated Reinforced Soil Slopes in Lieu of Concrete Walls.*** There are several turf reinforcement products on the market that could be used on a steep slope, in lieu of concrete walls. At this stage of design, the team did not feel that a defendable cost and quantity could be developed. It is recommended that, during final design, these types of products on steep slopes could be recommended. However, maintenance is increased.

23. ***Identify and Acquire the Footprint (Real Estate) as Soon as Possible.*** This project involves a substantial amount of real estate acquisition. It would help the project progress if the real estate requirement were established early on in the process and identified. This may preclude construction of new buildings and infrastructure that would have to then be removed at a higher cost.

24. ***Externalize Relocation Cost.*** This project involves a substantial amount of utility relocations. As with real estate as discussed above the requirement should be identified as soon as possible and communicated to the effected utilities.

25. ***Use Project Features for Multi Purposes.*** Every project element should have at least two functions, e.g. paths for O&M may also function as wildlife passages, towers keep people out of the habitat while providing bird perches, public education, and O&M functions.

26. ***Add Bird Towers.*** Birds are an important, and highly visible part of the ecosystem. Birds are important ecologically as well as economically. They are vital links in many food webs, and often serve as biological indicators of overall ecosystem health. Providing bird towers/areas provide essential habitat for one or more species of bird, including sites for breeding, wintering, and/or migrating birds. This will include bird monitoring, habitat restoration, land protection, and proposing changes to municipal land use policies.

27. ***Identify Multi-Uses for Staging Areas.*** Construction staging areas can also be used to host shop and job activities to support the project, such as materials remanufacturing.

28. ***Examine Types and Costs of Plants and Trees to be Purchased.*** Consider life cycle cost of selected trees/plants, including their ability to thrive, survive high flow events, the need for water, need to be replaced, what kind of maintenance required, etc. Also purchasing plants at cheaper unit costs should be evaluated and possibilities to use non-certified or non-traditional suppliers (to reduce cost) should be explored. Seed banking for future use is also an option to reduce cost.

SUPPORTING DOCUMENTS

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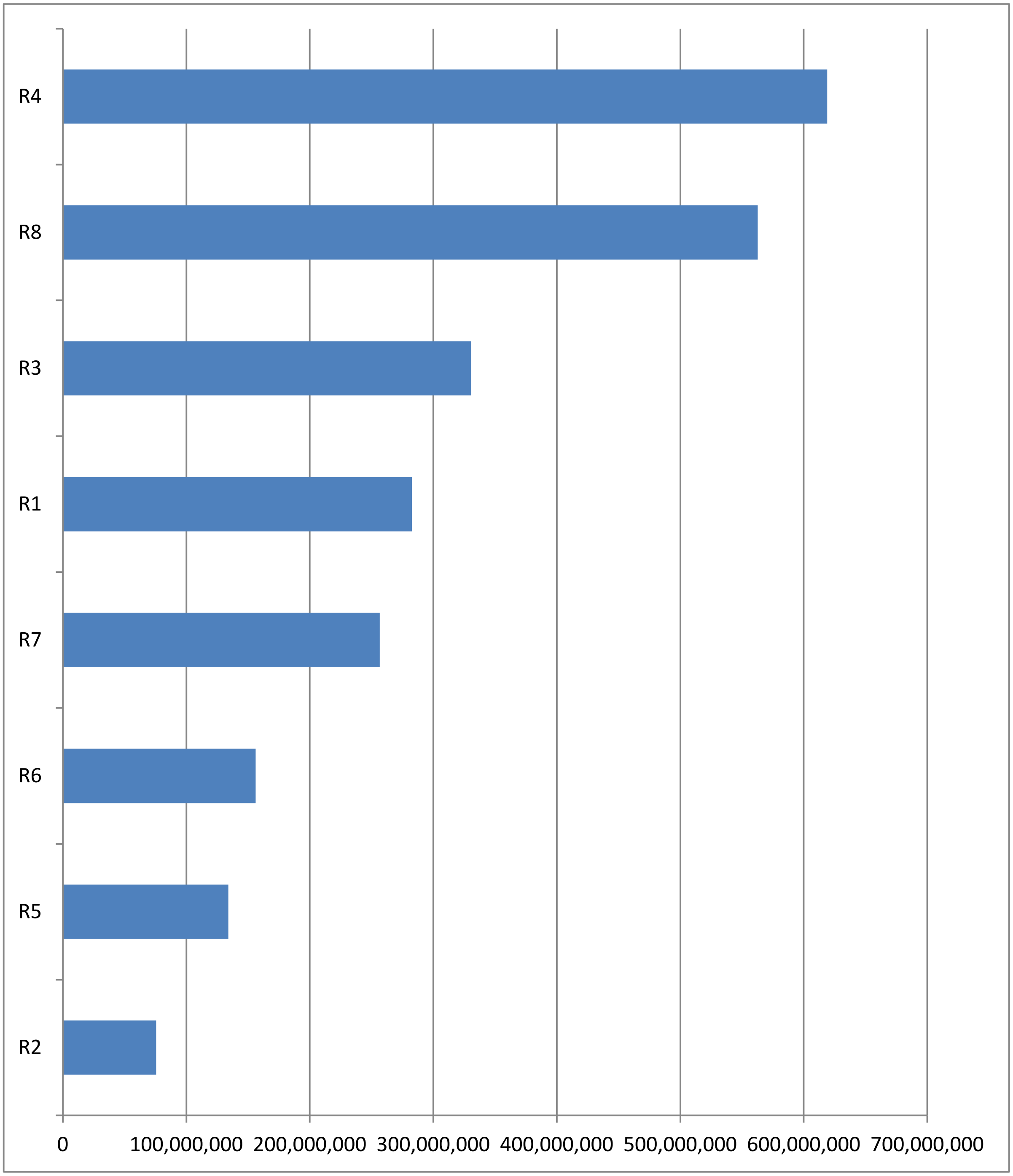
SPECULATION LIST

P	1	modify the terraces
C	2	redesign terraces - see 31
P	3	down scale the planter boxes
C	4	aquire more land
X	5	use alternative materials for concrete
C	6	increase in-channel vegetation
C	7	recycle existing concrete
C	8	recycle all hard material
C	9	use project features for multi purposes
C	10	increase vehicular access
C	11	increase shade
C	12	use vegitated reinforced soil slopes in lieu of concrete walls
C	13	use differently armored banks
C	14	add viewing stations
C	15	add bird tower
X	16	bury the railroads
P	17	develop mass balance from materials
X	18	bury the freeways
C	19	creatively finance across Corp mission
C	20	use adjacent areas for any mitigation
X	21	examine additional flood control feature during project
P	22	increase the channel complexities
X	23	cover the channel
P	24	use wrought iron fence in lieu of chain link
P	25	remove most of the fences
C	26	allow natural sedimentation to act as fill
X	27	conduct a sediment study
X	28	use islands for borrow
P	29	use random material for grade control structures
X	30	use inflatable dams to increase open water habitat
P	31	use sheet pile walls in lieu of concrete
X	32	use vinyl sheet pile
X	33	reduce the geotechnical factors of safety
X	34	reduce the structural factores of safety
X	35	use temporary structures

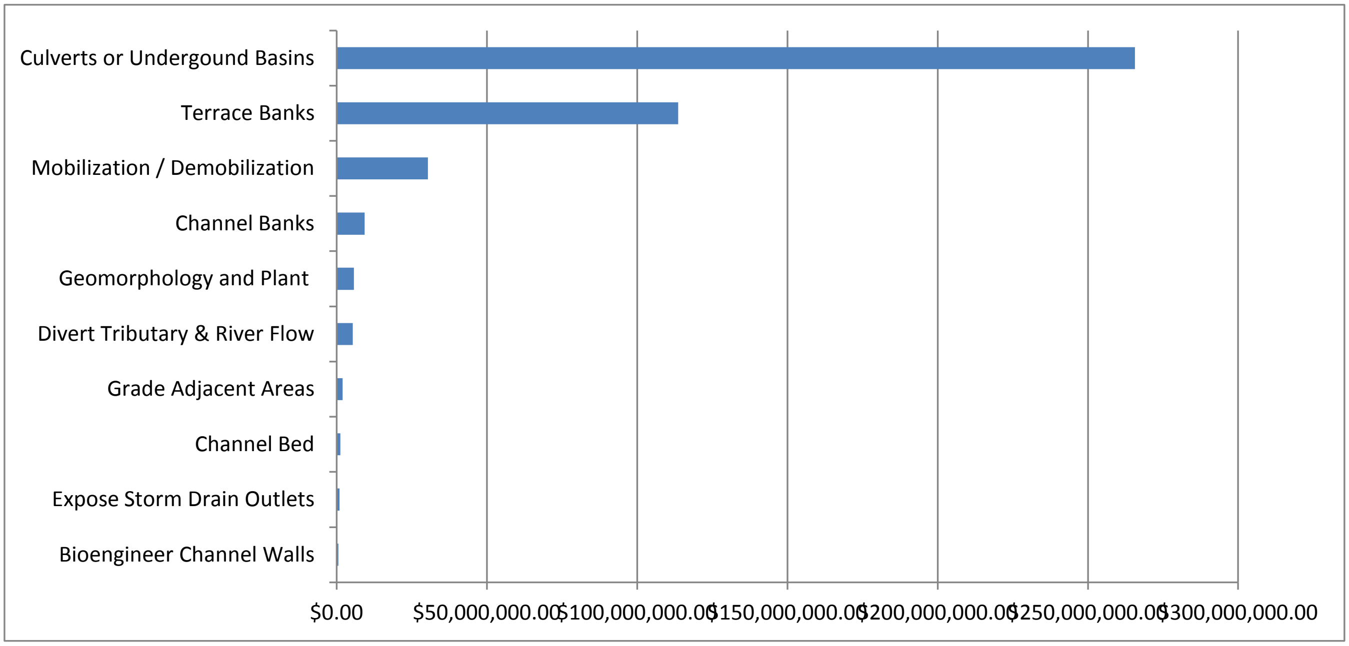
C	36	increase capacity by lowering maintainance roads
X	37	use shot crete for terraces
P	38	use pre cast planters
X	39	all materials should be sourced locally
X	40	use a supply contractor for pre cast planters
C	41	identify multi uses for staging areas
P	42	build pre cast planters into existing riprap - see 38
P	43	modularize the terrace planters
X	44	use gabions with or without recycled concrete
X	45	use a-jacks for riprap and concrete
X	46	use untreated wood for planters
X	47	concentrate investment in one area
C	48	build one small area first as an example
C	49	build the most intensive areas first
X	50	build it all in one contract
X	51	use design build contracts
C	52	use strategic maintainance methods
BD	53	use local labor and organizations for maintainance
C	54	focus sites which improves connectivity with the San Gabriel and Santa Monica Mountains
C	55	reduce the roughness coefficients in the hydrualic analysis
C	56	examine types and costs of plants and trees to be purchased
X	57	establish area to grow plant then harvest (i.e. plant farm)
X	58	add injection wells
X	59	add wells for water supply
X	60	capturing up stream flows to improve downstream habitat
X	61	reduce sediment transport (improve downstream habitat) and reduce cost of dredging
X	62	Sediment traps for island creation
X	63	use colored concrete
C	64	use scarified concrete surfaces
X	65	do not build to seismic standards
C	66	identify and acquire the footprint (real estate) as soon as possible
C	67	externalize relocation cost
X	68	use rock columns in lieu of concrete planters
X	69	use geo-grid
BD	70	use adaptive management
X	71	narrow the maintainance road

COST MODELS

Cost by Reach



The cost for Reach Four is presented below as an example.
The underground basins have since been removed.



FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

FAST DIAGRAM FOR THE LA RIVER ECOSYSTEM RESTORATION