

*King County Puget Sound Beach CSO Control Projects
Alternative Screening Workshop for Murray Basin*

Alternative Screening Workshop for Murray Basin

Dec. 9, 2009; Dec. 16, 2009; and Jan. 27, 2010

King Street Center

Summary of Discussion

Attendance

<i>King County</i>		<i>Consultant</i>	<i>SPU</i>
Betsy Cooper	John Phillips	Ellen Blair	Sahba Mohandessi
Hien Dung	Kevin Schock	Jennifer Corrigan	
Pam Erstad	Linda Sullivan	Kevin Dour	
Ron Kohler	Bob Swarner	Jeff Lykken	
Tiffany McClaskey	Martha Tuttle	Brian Matson	
Sue Meyer	Jim Weber	Allen de Steiguer	
Shahzad Namini	Mary Wohleb	Lloyd Skinner	
Chris Okuda	Monica Van der Vieren	Bob Wheeler	

Purpose of this Summary:

This document provides a summary of the workshop process and captures the discussion themes that supported recommendations for CSO control project alternatives to be forwarded for review by internal management and further development by the project team.

Workshop Process

Team members used a collaborative approach to screen alternative means for CSO control using a range of factors. The work was accomplished through a series of meetings on Dec. 9, 2009; Dec. 16, 2009 and Jan. 27, 2010 and is part of the team evaluation process to identify three CSO control alternatives for further evaluation. Documenting the workshop process is a critical piece of the project.

Workshop Goals and Objectives:

1. Recommend three alternative means for CSO control for the Murray Basin to present the public for input and to develop in more detail, with the remaining alternatives to be tabled at this time.
2. Where possible, recommend a set of alternative means that represents the range of complexity and constraints in the basin.
3. Discuss and document the reasons and rationale for recommendations.

December 9, 2009 Workshop – “Straw Poll”

Materials Available for Workshop

1. Final revised Murray Basin Alternatives summary sheets (1 for each alternative)

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2. Final revised table of selection factors ratings and descriptions of Low, Moderate, and High impact
3. Final revised Alternative Rating Sheets for Murray Basin (summary & expanded to include description of ratings)
4. Summary of major changes to Barton, Murray, and South Magnolia Basin Alternatives and overall selection factors
5. Inventory of Available Property and Property Profiles

Workshop Approach/Agenda

A "Straw Poll" was conducted to generate discussion and help inform the team's recommendations.

An enlarged chart of the screening factors and draft ratings for all alternatives for the Murray basin was posted on the wall. King County staff used dot stickers to indicate the alternatives they thought should be recommended for further evaluation and those they thought should not be recommended. Most importantly, staff also wrote their thoughts on the wall charts as to why certain alternatives should or should not be recommended as well as any questions they might have.

Workshop Outcome

The straw poll provided staff with an initial, visual survey of how their colleagues viewed the alternatives, and provided valuable insight into the reasons for their views. This initial survey and the written thoughts were used to start an in-depth discussion of the alternatives at the Dec. 16, 2009 workshop.

December 16, 2010 – *Initial Murray Alternatives Narrowing*

Materials Available for Workshop

1. Preliminary planning level cost information for comparison purposes for Murray Basin
2. Initial Straw Poll Results

Workshop Approach/Agenda

1. *Review of Initial Straw Poll Results for Murray* (Jeff Lykken, Tetra Tech)
2. *Initial Murray Alternatives Narrowing - Discussion* (facilitated by Bob Wheeler, Triangle Associates)
 - Identify alternatives that clearly do not merit further consideration at this time
 - Identify alternatives that clearly merit further consideration at this time
 - Discussion of remaining alternatives to reduce the recommended number to three
 - Discussion of basis for recommendations on all alternatives
3. *Presentation of Preliminary Planning Level Cost Information for Comparison Purposes* (Kevin Dour, Tetra Tech)
 - Methodology for determining costs
 - Review of methodology for creating comparative cost ratings

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- Discussion of whether cost information changes any of the three alternatives currently identified for further evaluation

4. Team Agreement on 3 Alternative means for CSO control for Further Development
(facilitated by Bob Wheeler, Triangle Associates)

- Survey of team for confidence in recommended alternatives
- Final thoughts on recommendations

Workshop Outcome

King County staff recommended the following alternative means for CSO control to be considered for further development:

- Rectangular Storage, Bottom of Basin (Alternative 1A)
- Distributed Storage Beach Drive & Murray Ave (Alternative 1C)
- Bottom of Basin - Combined Pipe/Rectangular Storage (Alternative 1F)
- Peak Flow Reduction Combined w/Storage (Alternative 5A).

Staff requested additional evaluation of Alternative 5A to determine whether peak flow reduction could be accomplished by roof drain disconnection from the sewer system rather than a combination of residential disconnection and redirection of street flows. Eliminating street flows avoids the potential need for stormwater treatment infrastructure to address water quality requirements. Staff proposed that Alternative 5A be evaluated in parallel if peak flow reduction from rooftops could be used to eliminate the pipe storage in Murray Ave that is part of Alternative 1C.

The engineering basin leads, Jeff Lykken and Kevin Dour, for the Murray Basin supported these choices.

January 27, 2010 - Follow up Meeting

Meeting Approach/Agenda

Alternative 5A was subjected to additional investigation and the results were presented at the January 27, 2010 project team meeting. The project team had considered impervious area disconnection (installation of storm sewers) and green stormwater infrastructure (rain gardens; bioswales) in the Murray basin. Hydraulic modeling indicated that there is not enough connected impervious area available throughout the entire basin to eliminate the need for “gray” infrastructure (storage or treatment). Analysis showed that the required storage volume could be reduced by 15-20% if large areas of connected street runoff and roof runoff were disconnected from the CSO system.

Meeting Outcome

King County staff recommended that Alternative 5A not be further developed at this time since it involves considerably higher costs and does not substantially reduce the challenges of constructing the remaining necessary storage at the bottom of the basin.

Staff recommended that the following alternative means for CSO control be considered for further development:

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- Rectangular Storage, Bottom of Basin (Alternative 1A)
- Distributed Storage Beach Drive & Murray Ave (Alternative 1C)
- Bottom of Basin - Combined Pipe/Rectangular Storage (Alternative 1F)

Summary of Workshop Process Discussion for Murray Basin

Considerations for all CSO Project Basins

- Several issues related to Operations/Maintenance activities were raised:
 - The costs and availability of water to flush storage facilities should be considered during the next phase as alternatives are refined.
 - Using a weir to passively capture flow is simpler than using telemetry and other controls to capture flows, but weirs still require careful design to insure that height is correct for projected flows. Also, Operations staff has to monitor for sedimentation and may need to manage issues.
 - A CSO treatment facility is much more complex operationally than storage.
 - Life cycle costs have not been calculated yet, but O&M costs will be small compared to capital costs for the alternatives.

Considerations for Murray Basin

- An emergency generator and odor control upgrade project is planned for the Murray Pump Station. Further work on this project was deferred until the CSO alternatives in the Murray basin were narrowed to see if there would be opportunities to combine the projects; thereby reducing neighborhood impacts. Combining the upgrade and CSO control projects may reduce community impacts, permitting requirements, and costs. As the CSO control alternatives are narrowed and refined, WTD management will determine if the emergency generator and odor control upgrade project can be combined with the CSO control project.
- The King County Puget Sound Beach CSO Control Projects project manager will review past discussions with Seattle City Light regarding power line extension to provide electricity to facilities.

Considerations for Murray Basin CSO Control Alternatives

Alternative 1A: Rectangular Storage, Bottom of Basin (Recommended for further development)

Design Engineering

- All of the peak flow is captured using passive technology. This is the least technically complex method for CSO control.
- This alternative can be combined with the required emergency generator and odor control project at Murray pump station.
- Some amount of storage or pumping capacity will need to be added at the Murray pump station because of increased flows from the upgraded Barton pump station. This alternative features a single facility that can control CSOs and manage the additional flows from Barton without adding additional pumping capacity at Murray.

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Cost

- Low planning level cost relative to other Murray CSO control alternatives.
- Off-street construction limits avoids permitting costs associated with street right-of-way construction.

Land Use/Permitting

- Sufficient space to accommodate staging and construction.
- May require property acquisition.
- Construction might be required in Lowman Beach Park. The Seattle Dept. of Parks and Recreation has a policy that opposes the use of parks for certain types of utilities. This could impact the project schedule.
- Work is located within shoreline zone. A Plan Shoreline Permit from the City of Seattle may be needed, in which case a formal alternatives analysis would be required. This could extend the project schedule.

Environmental

No discussion. Environmental comments were captured in the evaluation document for the Murray basin CSO control alternatives.

Community Impact

- Off-street construction limits traffic impacts in residential area with limited access.
- Construction would cause temporary reduction in recreational use of Lowman Beach Park.
- Small above-ground facilities may cause limited but permanent reduction in accessible park area.
- Some community members have expressed strong opposition to additional utility work in Lowman Beach Park.
- May require property acquisition.

O&M

- O&M access already exists in the park.

Alternative 1B: Circular Storage, Murray Ave & Lincoln Park Way (Not recommended for further development)

Design Engineering

- About half of basin peak flow is captured using passive technology (with peak flow pump station, 100% of peak would be captured and directed to circular storage tank). Moderate level of technical complexity and operational management compared to other CSO control approaches.
- Soft ground associated with stream flows may be difficult to construct on.

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Cost

- Off-street construction avoids permitting costs associated with street right-of-way construction.

Land Use/Permitting

- Could potentially use City of Seattle-owned property.
- If greenbelt is not used, requires purchase of residential properties.

Environmental

- Potential facility location is designated a critical area (environmental) and permitting could extend the project schedule or make the project infeasible.
- The site has steep slopes which might make it difficult to permit the project.

Community Impact

- Requires peak flow pump station at bottom of basin in addition to the storage facility to pump additional flows from Barton.
- Potential facility location is identified as a greenbelt in a neighborhood plan. Community members may oppose any construction there.
- Off-street construction limits traffic impacts in residential area with limited access.

O&M

- Circular storage requires more frequent maintenance and more staff time than rectangular or pipe storage.

Alternative 1C: Distributed Storage Beach Drive & Murray Ave (Recommended for further development)

Design Engineering

- All of the peak flow is captured using passive technology.
- Two storage facilities are considered technically more complex than a single, bottom of the basin storage facility.
- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.
- Some amount of storage or pumping capacity will be required at the Murray pump station to accommodate increased flows from the upgraded Barton pump station. This alternative can control peak flows within the Murray basin while accommodating increased flows from Barton without adding additional pumping capacity at Murray.

Cost

- Potential for relocation of utilities in ROW could result in additional construction costs.

Land Use/Permitting

- Project is mostly located within right-of-way. Would not require use of Lowman Beach Park or purchase of residential properties.

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Environmental

- Minimal environmental impacts.

Community Impact

- Project is mostly located within right-of-way. Would not require use of Lowman Beach Park or purchase of residential properties.
- Relocation of sanitary sewer, water and other underground utilities will be required along Beach Drive and Murray Ave SW. This may result in utility disruptions during construction.
- Construction would be very disruptive to street right-of-way for Beach Drive and Murray Ave. However, construction impacts are not static in a single area because of open cut & cover construction.

O&M

- Telemetry and instrumentation will be necessary to predict and capture projected flows. Flow management by telemetry for multiple facilities is more complex compared to passively capturing all of basin flow at one location at the bottom of the basin.
- Access for O&M staff poses traffic control and safety issues. Accessibility would be limited and require traffic control if entry were within the paved road. Site access structures off the roadway could increase project complexity.

Alternative 1D: Bottom of Basin – Tunneling (Not recommended for further development)

Design Engineering

- All of the peak flow is captured using passive technology. This is the least technically complex means to meet the CSO control requirement.
- No on-the-ground geotechnical investigations have been done to confirm that the material is suitable for tunneling. Investigation may show that tunneling is not feasible in this location.
- Tunneling is a more complex construction method than cut-and-cover.
- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.

Cost

No discussion. Comments related to cost were captured in evaluation document.

Land Use/Permitting

- Any easement requirements for boring under private property were not considered in the selection factors.

Environmental

No discussion. Environmental comments were captured in evaluation document.

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Community Impact

- Tunneling portals would require large areas in a compact, residential neighborhood.
- Construction would completely block Beach Drive near Lowman Beach Park, which is the only access route to residences south of the park.
- Avoids construction in most of Lowman Beach Park. Construction would likely occur in a portion of the park, in the vicinity of the existing Murray pump station.
- Relocation of sanitary sewer, water and other underground utilities would be required along Beach Drive. This may result in utility disruptions.

O&M

No discussion. Comments related to O&M were captured in the evaluation document.

<i>Alternative 1E: Upper Basin Storage (Not recommended for further development)</i>
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Design Engineering

- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.

Cost

- High cost compared to other Murray CSO control alternatives.

Land Use/Permitting

- Construction might be required in Lowman Beach Park. The Seattle Dept. of Parks and Recreation has a policy that opposes the use of parks for certain types of utilities. This could impact the project schedule.
- Work is located within shoreline zone. A Plan Shoreline Permit from the City of Seattle may be needed, in which case a formal alternatives analysis would be required. This could extend the project schedule.

Environmental

No discussion. Environmental comments were captured in evaluation document.

Community Impact

- 32 mgd pump station would be needed at the bottom of basin.
- Temporary and permanent impacts to multiple areas in the Murray basin. Construction impacts and a permanent facility at the bottom of the basin, construction impacts and a permanent facility in the upper basin, and construction impacts to 2550 lineal feet of street right-of-way.
- Community has historically opposed additional utility location in Lowman Beach Park.
- Relocation of sanitary sewer, water and other underground utilities may be required along Beach Drive. This may result in utility disruptions.

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O&M

- Telemetry and instrumentation will be necessary to monitor and control storage volume in upper basin. Flows would be diverted passively by gravity to peak flow pump station at bottom of basin.

Alternative 1F: Bottom of Basin - Combined Pipe/Rectangular Storage (Recommended for further development)

Design Engineering

- All of the peak flow is captured using passive technology.
- Although this alternative involves multiple facilities, they are located proximal to each other and management is less complicated than distributed storage.
- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.

Cost

- Low cost relative to other Murray CSO control alternatives.

Land Use/Permitting

- Avoids construction in Lowman Beach Park and in the shoreline zone.
- Requires purchase of residential properties.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- Construction would be located in Beach Drive right-of-way resulting in traffic disruptions over a long period of time.
- Relocation of sanitary sewer, water and other underground utilities may be required along Beach Drive. This may result in utility disruptions.
- Requires purchase of residential properties.

O&M

- Multiple facilities will require more maintenance and are not as easy to manage as a single facility.

Alternative 2A: Convey & Treat at Alki (Not recommended for further development)

Design Engineering

- The capacity of the Alki CSO treatment facility and outfall would need to be evaluated and likely upgraded for discharging additional flows to Puget Sound.

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- Would require upgrades to the existing 63rd Street pump station and the Alki treatment facility to handle the additional flows.
- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.

Cost

- High cost compared to other Murray CSO control alternatives.

Land Use/Permitting

- Work is located within shoreline zone. A Plan Shoreline Permit from the City of Seattle may be needed, in which case a formal alternatives analysis would be required. This could extend the project schedule.
- Construction might be required in Lowman Beach Park. The Seattle Dept. of Parks and Recreation has a policy that opposes the use of parks for certain types of utilities. This could impact the project schedule.

Environmental

- The capacity of the Alki CSO treatment facility and outfall would need to be evaluated and likely upgraded for discharging additional flows to Puget Sound.
- Permitting effluent discharge to Puget Sound could delay the project schedule.

Community Impact

- Construction would be disruptive for residents, park users, and commuters:
 - Construction of 13,500 lineal feet of force main in Beach Drive.
 - Would require upgrades to the existing 63rd Street pump station and the Alki treatment facility to handle the additional flows.
 - Would require construction of a 28.5 mgd peak flow pump station at the bottom of the basin, possibly in Lowman Beach Park.
- If Lowman Beach Park is not used, it would be necessary to purchase residential properties to site the peak flow pump station.
- Community has historically opposed additional utility location in Lowman Beach Park

O&M

No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 3A - End of Pipe Treatment, Bottom of Basin (Not recommended for further development)

Design Engineering

- Technically complex.
- This alternative can be combined with the planned emergency generator and odor control project at Murray pump station.
- This alternative can control CSOs and manage the additional flows from Barton Pump Station without adding additional pumping capacity at Murray.

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Cost

- High cost relative to all other Murray CSO control alternatives.

Land Use/Permitting

- Treatment facility in shoreline is currently prohibited by code.
- Construction might be required in Lowman Beach Park. The Seattle Dept. of Parks and Recreation has a policy that opposes the use of parks for certain types of utilities. This could impact the project schedule.
- If Lowman Beach Park is not used, it would be necessary to purchase residential properties to site the storage facility.

Environmental

- Permitting effluent discharge to Puget Sound could delay the project schedule.

Community Impact

- Community members may object to treatment facility in residential neighborhood.
- Community has historically opposed additional utility location in Lowman Beach Park
- If Lowman Beach Park is not used, it would be necessary to purchase residential properties to site the storage facility.

O&M

- O&M more complicated and time-consuming for staff than storage.

Alternative 5A: Peak Flow Reduction Combined w/Storage (Not recommended for further development)

Design Engineering

- Storage volume required for CSO control will be reduced with effective rooftop disconnection. Flows to West Point Treatment Plant will also be reduced.
- Although more stormwater flows to the Combined Sewer System from streets than from roof drains, there may be enough acreage of connected roof drains to considerably reduce the amount of storage required in the basin.
- While it may take some time to achieve enough roof drain disconnects, the disconnect efforts can begin as soon as the Facility Plan is complete.
- May be challenging to identify sufficient stormwater sources that can be disconnected from the system to reliably reduce the storage volume to meet CSO control requirements.
- Some amount of storage or pumping capacity will need to be added at the Murray pump station because of increased flows from the upgraded Barton pump station. The Beach Drive storage facility can control CSOs and manage the additional flows from Barton Pump Station without adding additional pumping capacity at Murray.
- The Beach Drive storage facility can be combined with the planned emergency generator and odor control project at Murray pump station.

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Cost

- If only areas with existing stormwater systems are targeted to meet the project goal, permitting and construction costs might be lower than initially anticipated because no new stormwater pipes will be needed.

Land Use/Permitting

- The King County CSO Program is interested in roof drain disconnects as a way to control CSOs. Other agencies have had success with roof drain disconnects. The City of Seattle has an operational roof drain disconnect program and they have offered to partner and cost-share with King County to encourage people to redirect their roof drains to the stormwater system in partially separated basins.
- Department of Ecology and EPA have indicated interest in “source control” as a way to control CSOs.
- The storage facility would not require use of Lowman Beach Park or acquisition of residential properties.

Environmental

- If only roof drain disconnection is needed to meet the project goal, and not street disconnection, Department of Ecology does not require additional treatment of stormwater.

Community Impact

- Many community members have expressed interest in an option other than a traditional “gray” facility.
- Project schedule could be considerably delayed because of need to coordinate with City of Seattle and work required on hundreds of private properties.
- Construction of storage facility would be very disruptive to street right-of-way for Beach Drive.
- Relocation of sanitary sewer, water and other underground utilities would be required along Beach Drive. This may result in utility disruptions.

O&M

- Access for O&M staff poses traffic control and safety issues. Accessibility would be limited and require traffic control if entry were within the paved road. Site access structures off the roadway could increase project complexity.

Alternative Narrowing Process

11/23/09

The Purposes of December King County CSO Narrowing Workshops

1. Describe and respond to King County staff clarifying questions related to the narrowing process.
2. Provide an opportunity for King County staff to ask questions and for clarifications of the criteria and ratings and then confirm the criteria and ratings.
3. Conduct an initial straw poll with King County staff of their Alternative preferences
4. Primarily to narrow the 9 alternatives for each Basin to three alternatives that will be further evaluated and considered.
5. Important though is to provide the reasons and justification on why alternatives were and were not selected for public, agency, and participants' understanding.

What Information Will We Have?

1. Final revised Barton, Murray, and South Magnolia Basin Alternatives summary sheets (1 for each alternative).
2. Final revised table of criteria ratings and descriptions of Low, Moderate, and High impact.
3. Final revised Alternative Rating Sheets for Barton, Murray, and South Magnolia Basins (summary & expanded to include description of ratings).
4. Comment logs relating to Barton, Murray, and South Magnolia Basin Alternatives.
5. Summary of major changes to Barton, Murray, and South Magnolia Basin Alternatives and overall evaluation criteria.
6. Cost information for Barton, Murray, and South Magnolia Basins.
7. Community input from public meetings
8. Initial Straw Poll Results (Available after December 9th Workshop)

What process Will We Use?

1. King County staff will ask questions and for clarifications of the criteria and ratings.
2. King County staff will confirm the criteria and the ratings for use in the narrowing of the 9 Alternatives to 3 Alternatives
3. King County staff will participate in an initial Straw Poll of Alternative preferences
4. Directions for Straw Poll Preference Process
 - o For each Basin there will be an enlarged wall chart of the criteria and ratings for all Alternatives for that Basin
 - o For all King County staff, 3 Green Dots and unlimited Red Dots
 - o King County staff place Green Dots on Alternatives that they believe should move forward for further evaluation and consideration, if any
 - o King County staff place Red Dots on Alternatives that should not move forward, if any
 - o King County staff write on wall charts their justifications and rationales for why any Alternative should be considered further or why it should not be considered further

MURRAY BASIN ALTERNATIVES
 PRELIMINARY DRAFT DISCUSSION PURPOSES ONLY

CATEGORY / CRITERIA	1A	1B	1C	1D	1E	1F	2A	3A	5A
LAND USE AND PERMITTING									
1. Land Use Compatibility	1	2	2	2	1	2	1	1	2
2. City of Seattle Planning Policies (Comp Plan)	2	2	3	3	2	2	2	1	3
3. Municipal Code and Shoreline Management Program	1	3	3	3	1	2	1	1	3
4. Permitting Complexity	2	2	2	2	2	2	1	1	2
5. Property Acquisition Complexity	1	2	2	2	1	2	1	1	2
ENVIRONMENT									
1. Cultural Resources	2	2	2	2	2	2	2	2	2
2. Fish and Wildlife	3	2	3	3	3	2	3	3	2
3. Wetlands and Streams	2	1	2	2	3	2	3	2	2
4. Soils and Sediments	3	1	3	3	2	2	3	3	2
5. Water Quality	3	3	3	3	3	3	3	3	2
TECHNICAL									
1. Technical Complexity	3	2	2	3	2	2	2	1	3
2. Compatibility with Existing WW system	2	2	2	2	2	2	1	3	3
3. Flexibility/Adaptive Management	2	2	2	2	3	3	2	2	2
4. Constructability/Implementation Schedule	2	2	2	1	2	3	2	2	2
O&M									
1. Staffing	3	2	3	3	2	3	2	1	3
2. Training	3	3	3	3	3	3	3	1	3
3. Reliability	3	2	2	3	2	3	2	2	3
4. Maintenance	3	2	2	2	2	3	2	1	3
5. Safety	3	3	1	1	3	1	3	3	2
COST EFFECTIVENESS									
1. Project Capital Costs	3	3	2	2	1	3	1	1	2
2. Life Cycle Costs									
3. Cost Variability/Risk	3	3	3	3	3	3	2	3	2
COMMUNITY IMPACT									
1. Location	2	2	2	3	3	2	2	1	3
2. Long Term Risk, New Facilities	2	2	2	3	3	2	2	1	2
3. Construction Impacts	1	1	1	1	1	2	1	1	2

ALTERNATIVE DEVELOPMENT PHASE				
			Barton Basin	Murray Basin
CSO Control Approach	Configuration	Minimum Requirements for Potential Sites	Design Requirements: <ul style="list-style-type: none"> 110,000 gallon storage or 26 acres effective disconnection 	Design Requirements: <ul style="list-style-type: none"> 1.0 mg storage or 28.5 mgd conveyance or Up to 10 acres effective disconnection to reduce 300,000 gallons of storage
1. Convey & Treat	Peak flow pump station, pipeline to existing treatment facility	<ul style="list-style-type: none"> Flat (< 5%) open space near existing CSO Outside public Right-of-Way Sized for peak flow pump station 	Cannot increase conveyance capacity out to Murray Basin	Alternative 2-K Convey and Treat
2. Centralized/Distributed Storage				
A. Bottom of Basin	Rectangular/Circular Tank	<ul style="list-style-type: none"> Flat (< 5%) open space near existing CSO Outside public Right-of-Way Size dependent on storage volume 	Alternative 1-A Rectangular Storage Alternative 1-A Circular Storage Alternative 1-C Circular Storage	Alternative 1-G Rectangular Storage
	Linear (in-line) Pipe	<ul style="list-style-type: none"> Linear, flat (< 5%) open space near existing CSO Inside or outside public Right-of-Way Minimum 12-foot wide Length dependent on storage volume 	Alternative 1-A Pipe Storage Alternative 1-D Pipe Storage Alternative 1-E Pipe Storage	
	Deep Tunnel	<ul style="list-style-type: none"> Flat (< 5%) open space near existing CSO Flat (<5%) open space at access shaft (location dependent on storage volume) Both sites outside public Right-of-Way 		Alternative 1-J Pipe Storage
B. "Up-Basin"	Rectangular/Circular Tank	<ul style="list-style-type: none"> Flat (< 5%) open space Outside public Right-of-Way Size dependent on storage volume 	Alternative 1-B Rectangular Storage	Alternative 1-H Circular Storage
	Linear (in-line) Pipe	<ul style="list-style-type: none"> Linear, flat (< 5%) open space Inside or outside public Right-of-Way Minimum 12-foot wide Length dependent on storage volume 		
3. End of Pipe Treatment				
A. Bottom of Basin	New high rate treatment facility	<ul style="list-style-type: none"> Flat (< 5%) open space near existing CSO Outside public Right-of-Way Sized for treatment plant facilities and access 	Alternative 3-A – End of Pipe Treatment	Alternative 3-G – End of Pipe Treatment
B. "Up-Basin"	Peak flow pump station, pipeline to new high rate treatment facility	<ul style="list-style-type: none"> Flat (< 5%) open space near existing CSO, sized for peak flow pump station Flat (<5%) open space at treatment plant location, sized for treatment plant facilities and access Both sites outside public Right-of-Way 		
4. Peak Flow Reduction				
A. Stormwater Disconnection	Disconnection of impervious areas (roof drains and catch basins) with stormwater re-routed to new or existing MS4.	<ul style="list-style-type: none"> Available impervious area for disconnection Inside or outside public Right-of-Way 	Alternative 4-F – Stormwater Disconnection	Cannot achieve CSO control through disconnection alone in available CSO subbasins.
B. Green Stormwater Infrastructure (GSI)	Implementation of GSI techniques to limit stormwater response to rainfall	<ul style="list-style-type: none"> See GSI analysis for constraints 	TBD	TBD
5. Combined Approach				
A. Storage and Stormwater Disconnection	Disconnection of impervious areas to achieve reduction in required storage volume.	<ul style="list-style-type: none"> See Approach 2 and Approach 4 above. 	Can eliminate need for storage through disconnection in CSO sub-basin.	Alternative 5-J/L Combined Storage with Disconnection
NOTES:				