DICKPERRIGAULT
12/12/94

City of Tempe

Rio Salado Town Lake

Value Engineering Proposals

Response Document

CH2M HILL

December 1994

Rio Salado Town Lake
Value Engineering
Proposals Summary

No.	Proposal	Recom-mended? (Y/N)	Potential Construction Cost Savings ($000)
1.	Use displacement cast piles for cutoff walls in lieu of slurry walls.	N	
2.	Use sheet piles in lieu of slurry walls.	N	
3.	Move downstream dam to the west 3,500 feet.	N	NA
4.	Move the downstream dam upstream 220 feet to the existing grade control structure.	Y	1,320
5.	Recapture the infiltration for the potable water supply.	Y	2,530
6.	Use lake for CAWCD groundwater replenishment district.	N	
7.	Integrate the North and South Superfund site remediation for water supply and groundwater treatment.	Y	13,000
8.	Delete the slurry walls and increase the pumping rate to recover the water.	Y	9,400
9.	Develop a low cost water-applied seal to prevent infiltration from the lake.	Y	12,700
10.	Replace the upstream rubber dam with a sacrificial dam.	Y	5,500
11.	Construct the project in phases.	Y	20,000
12.	Windrow the lake bottom to improve the lake bottom seal.	N	
13.	Replace two of the skimmers/aerators with air injection in the recirculation lines.	N	
14.	Alternative to edge treatment and shoreline modifications.	N	
15.	Replace the Dorsey bypass with a stilling basin.	Y	240

Proposal #1:
Use displacement cast piles for cutoff walls in lieu of slurry walls.

Design Concept

Use a soil/bentonite slurry wall around the lake to reduce infiltration from the lake and prevent infiltration from affecting groundwater away from the site.

V.E. Proposal

Replace slurry cut-off wall with displacement cast piles. Displacement cast piles consist of a driven large displacement pile, which when withdrawn, is replaced by a bentonite slurry applied under pressure. The piles are continuously driven around the lake to create a wall.

Advantages of Proposal

The V.E team believed the displacement cast piles would be less expensive than the slurry wall.

Disadvantages of Proposal

- The proposal relies on the ability to drive 16-inch-diameter large displacement piles. Recently, only small displacement H-piles have been driven in the Salt River channel (Alma School Road Bridge, 24th St. Bridge). These piles were driven 20 to 30 feet below the ground surface. It is unlikely that large displacement piles could be driven effectively in the river channel due to the existence of cobbles and boulders.

- This method will not produce a cut-off wall that is as effective as a 4-foot-thick slurry wall. It is difficult to know how far into the formation the slurry will penetrate and what voids will be left open. Quality control is difficult with this method.

Unresolved/Unaddressed Issues

- This technique is unproved in this type of soil, while slurry trenches have been successfully constructed in this type of soil.

- It is unknown if the displacement piles can be driven at the site.

Estimated Construction Cost Savings

The V.E. team indicated that Construction Cost Savings would amount to about $660,000 with this proposed concept. The cost savings depend on the ability to drive the displacement

pile at $14 per lineal foot. It is possible to drive a 9-inch-diameter small displacement pipe pile using a Becker hammer drill rig. (This rig uses a pile hammer to drive a hollow pipe pile while removing the material from inside the pile with high pressure air.) The cost of this (proved) Becker method is about $30 per foot and the footage quantity would be doubled because of the smaller pile diameter. Using the $30 per foot price, the cost of just the pile driving with this method would be $30,000,000. This is significantly more expensive than the slurry wall.

Additional Design/Investigative Work

A test section of displacement cast pile wall would need to be constructed and evaluated during design.

Conclusions/Recommendations

This proposal is **not recommended**. This is an unproved technique with little potential for saving construction cost.

Proposal #2:
Use sheet piles in lieu of slurry walls.

Design Concept

Use a soil/bentonite slurry wall around the lake to reduce infiltration from the lake and prevent infiltration from affecting groundwater away from the site.

V.E. Proposal

Replace slurry cut-off wall with sheet pile. Interlocking sheet piles would be driven to form a cut-off wall around the lake.

Advantages of Proposal

The V.E team believed the sheet piles would be less expensive and quicker to construct than the slurry wall.

Disadvantages of Proposal

- The proposal relies on the ability to drive interlocking sheets . Recently, only small displacement H-piles have been driven in the Salt River channel (Alma School Road Bridge, 24th Street Bridge). These piles were driven 20 to 30 feet below the ground surface. Discussions with local geotechnical engineers (Agra E&E and Western Technology) were not optimistic about the ability to drive sheet piles in the Salt River channel. A local sheet pile contractor thought the sheet pile could be driven 30 to 40 feet deep but said they would be damaged and might not stay interlocked.

- A sheet pile wall is not as effective as a 4-foot-thick slurry wall for controlling infiltration. Sheet pile wall leak significantly at the interlocks even when the sheets stay together. Sheet pile wall systems with reduced leakage have been developed. (The Waterloo system, for example, relies on grouting the interlocks to reduce infiltration.) These proprietary systems are typically more expensive than conventional sheet piles.

- It is difficult to know if the sheet pile wall is intact after it is driven.

- It is difficult to drive sheet piles under the bridge crossings.

- The steel sheet piles could potentially corrode.

Unresolved/Unaddressed Issues:

- It is not known how effectively sheet piles can be driven at the site.
- The V.E. proposal did not include the cost of excavating and backfill to the toe of the CSA.

Estimated Construction Cost Savings

The V.E. team indicated estimated construction cost savings would be about $2,303,000 with this proposal. The cost savings is dependent on driving the displacement pile at $13 per square foot. This method would also require approximately 200,000 cubic yards of excavation at a cost of about $500,000. The contractor who could drive the sheet piles estimates the cost is in the range of $15 to $20 per square foot. The Waterloo system is in the range of $20 to $28 per square foot. Using $15 per square foot, the cost of the sheet pile wall would be $10,000,000. Adding the excavation and concrete cap would bring the total cost to $10,750,000, about the same cost as the slurry wall.

Additional Design/Investigative Work

A drivability test of the sheet pile wall would need to constructed and evaluated during design.

Conclusions/Recommendations

This proposal is **not recommended**. Wall is less effective than slurry wall at controlling infiltration, and at best, equal in cost to the slurry wall.

Proposal #3: Move downstream dam to the west 3,500 feet.

Design Concept

Locate the downstream dam approximately 200 feet downstream of Grade Control Structure #4.

V.E. Proposal

INVERT @ Priest 3' lower than design

Move the west dam downstream 3,000 to 3,500 feet west, to approximately 250 feet upstream of Priest Road. Raise the foundation to maintain a foundation elevation of 1132± using a concrete sill structure. This would allow the dam to be founded on rock material.

Advantages of Proposal

- Larger lake with increased developable frontage
- May make removal of the Rio Beach landfill economically feasible
- Better foundation materials may reduce foundation costs
- Reduces the need for downstream scour protection

Disadvantages of Proposal

- Adds costs for additional shoreline, modifiable water supply, evaporation
- Will increase length and cost of stormwater bypass
- Results in unacceptable rise in water surface elevation for design flood events in the Salt River (*FATAL FLAW*)
- Sedimentation impacts may also be unacceptable.

Conclusions/Recommendations

This alternative does not meet the design criteria set by FCDMC. Initial HEC-2 analysis indicates a rise in 100-year use to above the dike elevation upstream of the dam. To meet the criteria, the sill must be reduced to a maximum of 3 feet (this alternative requires 8 feet) and the size of the dam increased to 21 feet. The other potential option would be to move the entire lake west. Previous directions from Tempe staff have been that this is not an acceptable option. Therefore, this proposal is **not recommended**.

*

Proposal #4: Move dam upstream 220 feet to existing grade control structure.

Design Concept

The downstream dam was located at its current proposed location at the request of the City to be close to a future bridge crossing

V.E. Proposal

Move the downstream dam upstream 220 feet to the existing grade control structure.

Advantages of Proposal

- Building the dam on the existing grade control structure would require less RCC foundation material and less excavation.
- Dewatering requirements could be reduced because of reduced excavation.
- Reduced construction cost.
- Possibly reduces impacts on Rio Beach landfill

Disadvantages of Proposal

- Reduces the lake area by approximately 5 acres and the frontage by 440 feet. (TOTAL) 220' (N & S)

Unresolved/Unaddressed Issues

- Condition of existing grade control structure is unknown. As-builts of the structure are not available, and construction photographs are not available. According to ADOT inspectors, the bottom of the grade control structure was constructed under water by pushing 2 to 3 feet of soil cement into the water. The remaining portion of the structure was constructed in lifts as specified.
- Need details on the existing conditions of the grade control structure.

Estimated Construction Cost Savings

- The V.E. team indicated Construction Cost Savings could amount to about $1,320,000 with this proposal. More excavation and RCC may be required than estimated by the V.E. team, but significant savings should be possible.

- The V.E. team's estimated Construction Cost Savings do not take into account the value of the waterfront property to the City. In addition, the potential increase in life expectancy of the rubber dam resulting from partial shading of the adjacent bridge was not considered.

Additional Design/Investigative Work

- Additional investigation (2 to 3 borings) in the grade control structure.
- Redesign of the dam foundation. Moves further away from the southside landfill.

Conclusions/Recommendations

This proposal is **recommended**; it could save costs. Selection is dependent on where the City wants to place the dam.

Proposal #5: Recapture infiltration for potable water supply.

Design Concept

In the design concept, lake infiltration would be recovered with recovery wells (maximum pumping rate of 40 mgd) and returned to the lake. Up to 9,000 acre-feet per year (average flow of 8 mgd) could be delivered to the lake by SRP for recharge and subsequently recovered with City production wells (not included in the project) for potable use. Flows for recharge are limited by available SRP canal capacity of 15 cfs (22.5 mgd). A slurry wall to contain infiltration at the east end of the lake is included in the design concept.

V.E. Proposal

The V.E. proposal consists of eliminating the east slurry wall; recovering lake infiltration with recovery wells; disinfecting the recovered water at the wellhead; and pumping into the potable water supply system. SRP flows, which presently are treated at the Papago Water Treatment Plant (WTP), would be diverted to the lake. Percolating downward results in soil aquifer treatment (SAT) to cleanse the water, along with disinfection at each wellhead, which would produce potable water. For estimating operations and maintenance costs, two alternative infiltration rates were examined: an assumed infiltration rate of 2 ft/day (40 mgd) for Alternative 1 and 0.5 ft/day (16 mgd) for Alternative 2. Capital costs estimated assumed Alternative 1 conditions.

Advantages of Proposal

- Reduce production in surface water treatment plants and realize savings in operations and maintenance costs. Use Town Lake as a water treatment works.
- Water quality of Town Lake and groundwater would be enhanced.
- Eastern slurry wall could be eliminated.

Disadvantages of Proposal

- Less control of treatment for potable use with a SAT system than existing facilities.
- Disinfection facilities needed at each wellhead
- Additional infrastructure needed to convey canal water from Papago WTP delivery point to Town Lake.

Unresolved/Unaddressed Issues

- It is anticipated that the lake bottom will seal up and thus reduce the infiltration rate over time. In other locations, where deep lakes are used for recharge, the lakes are drained and the bottom is allowed to dry out at least twice per year to restore the infiltration rate.

- The impacts on groundwater conditions and related permitting issues would need to be addressed for storage of large quantities of recharged water underground.

- The V.E. team assumed that the design and costs for constructing the infiltration recovery wells was similar to the design concepts. Actually the design concept wells discharge to atmosphere at the wellhead, while recovery well pumping into the water supply system would require at least an additional 50 psi of pressure. This equates to at least an additional 125 HP of pump motor capacity at each of the ten 3,000 gpm recovery wells. This additional pumping capacity may not be practical to add to each well and may require separate booster pump station facilities.

- The V.E. proposal discusses savings in pumping costs, but does not consider booster pumping into the water supply system, nor the 100-foot difference in elevation between the Papago WTP and the recovery wells.

- Estimated costs for disinfection facilities at the wellhead appear low. Costs could be as high as $40,000 per well.

- The piping infrastructure needed to convey 40 mgd from the recovery wells into the potable water system assumes connections to a single waterline on Rural Road on each side of the river. The waterline in Rural Road would need to be 48-inch or larger to make these connection feasible. Only 9 of the 10 recovery wells were included in the piping infrastructure.

- For conveyance of SRP cross-cut canal flows to the lake, a 36-inch-diameter pipeline about 2,000 feet long was assumed. For 40 mgd, it is likely that a 48-inch pipeline will be needed; in addition, the distance from the SRP turnout at the Papago WTP to the lake is closer to 4,000 feet in length.

- This proposal assumed that the costs for make-up water to the lake could be avoided. Purchase and delivery of about 1,300 ac-ft/yr of make-up water will be needed *regardless* of the recharge and recovery activities. ADWR is not going to credit evaporative losses to the recharge account.

Estimated Construction Cost Savings

Eliminate east slurry walls	$	5,600,000
Additional booster pumping capacity		(800,000)
Wellhead disinfection		(400,000)
Piping infrastructure for water supply conveyance		(1,000,000)
Piping infrastructure for conveyance to the lake		(870,000)
Net Construction Cost Savings	$	2,530,000

Additional Design/Investigative Work

- This proposal would require additional design/investigative work to incorporate the potential for future connections between the recovery well discharge pipeline and the potable water supply system, and for the future addition of booster pumping facilities.

- Long-term infiltration rates, groundwater impacts of seasonal storage, water pumping and conveyance infrastructure requirements, and operations and maintenance costs would need more detailed assessment before the overall viability of this proposal could be determined.

Conclusions/Recommendations

Assuming that the east slurry walls are eliminated for other reasons, the additional construction cost for this proposal is about $3,000,000. Including the costs for booster pumping into the water supply system would reduce the potential savings between treatment at the WTP and SAT with recovery wells and wellhead disinfection.

The infrastructure needs for this proposal that would be affected by implementation of the project as contained in the design concept are the conveyance facilities from the recovery wells to the water supply system. Thus, incorporating the potential for making future connections between the recovery wells and the potable water supply system could probably maintain this proposal as a future viable option with low additional costs. It is **recommended** that provisions for implementing this proposal be incorporated into the design of Town Lake facilities, whenever practical.

Proposal #6: Use lake for CAWCD Groundwater Replenishment District.

Design Concept

Up to 9,000 ac-ft/yr of water may be recharged for future withdrawal by the City of Tempe. This rate was chosen based on available capacity from the SRP canal system and anticipated long-term infiltration rates from the lake.

V.E. Proposal

The proposal is to use the lake as a recharge project in conjunction with Central Arizona Water Conservation District's (CAWCD) Groundwater Replenishment District (GRD) program. Additional infrastructure would be needed to convey canal water from SRP's Cross-cut Canal to Town Lake. CAP water would be conveyed through the SRP canal system for recharge, up to 100,000 ac-ft/yr. CAWCD would operate the recharge functions of the lake and surrounding cities who subscribe to the GRD would pay the costs (CAP water plus O&M and administrative costs). Tempe would be in a position to receive a reduced rate by providing recharge facilities.

Advantages of Proposal

- Slurry walls and infiltration recovery system could be eliminated.
- CAWCD could pick up the additional cost of infrastructure to conduct large scale recharge.
- Low-cost participation in the GRD for Tempe.

Disadvantages of Proposal

- Many technical and institutional issues would need to be investigated before feasibility of this proposal can be determined.
- Coordination and financial arrangements would be needed with another agency to construct project facilities.

Unresolved/Unaddressed Issues

- It is anticipated that the lake bottom will seal up and thus reduce the infiltration rate over time. In other locales, where deep lakes are used for recharge, the lakes are drained and the bottom is allowed to dry out at least twice per year to restore the infiltration rate.

- The impacts on groundwater conditions and related permitting issues would need to be addressed for storage of large quantities of recharged water underground.

- Determining the available capacity and timing restrictions to convey large quantities of water through the SRP canal system to the Cross-cut Canal needs verification.

- Recharging 100,000 ac-ft/yr may not be practical due to harmful groundwater impacts, low lake infiltration rates, and lack of capacity in the SRP canal system.

Estimated Construction Costs Savings

Eliminate slurry walls	$	11,600,000
Eliminate infiltration recovery system		2,200,000
Net Construction Cost Savings	$	13,800,000

Additional Design/Investigative Work

This proposal would require additional investigations of expected long-term infiltration rates, groundwater impacts, delivery capacity of the SRP canal system, and CAWCD's willingness to do a cooperative project.

Conclusions/Recommendations

This proposal is **not recommended**. The institutional and technical issues associated with this proposal are complicated and difficult to resolve prior to construction. Compatibility at CAWCD recharge operations and COT lake operations is a key concern. This proposal could be implemented *after* lake construction, and still achieve cost savings by obtaining CAWCD financial contributions.

Proposal #7: Integrate the North and South IBW site remediation

Design Concept

Use a system of slurry walls and high-capacity infiltration management wells to prevent lake infiltration from affecting groundwater away from site.

V.E. Proposal

Do not build slurry walls or infiltration management wells and instead allow lake infiltration to move laterally away from the lake and enhance the movement of contaminants at the IBW-South site.

Advantages of Proposal

- Potential cost savings of not building slurry walls and infiltration management wells
- Eliminates the concern about the lake creating unexpected effects on Superfund sites (even if had slurry walls and infiltration management wells)
- Uses the fact that the sites are hydraulically connected to the potential benefit of both Tempe and EPA
- THE WATER WILL BE FREE TO TEMPE.

Disadvantages of Proposal

- If lake infiltration greatly changes groundwater flow directions, could render existing EPA monitoring wells ineffective and require new wells
- Relies on other parties (i.e., EPA timing to install IBW-South extraction wells may not coincide with COT's anticipated schedule)
- Would likely require enormous amount of planning and legal agreements between all concerned parties (COT, EPA, ADEQ, PRPs, public groups, etc.)
- Public perception that lake water is contaminated.

Unresolved/Unaddressed Issues

- Impact on IBW-North site not considered adequately (PRPs and public would likely be concerned with uncontrolled flushing of contaminants to north)

- Not building a slurry wall at downstream end could have negative and unacceptable impacts on Rio Beach landfill

- Not clear whether existing canal system has the capacity to deliver 20+ mgd indefinitely

- Proposed cost savings assume that COT will not pay any construction or water treatment cost, which is probably unrealistic

Estimated Construction Cost Savings

- Proposal, as stated, could result in about $11.6 million in saved construction costs if the proposed slurry walls were eliminated, plus about $2.2 million in saved construction costs if the infiltration management wells were eliminated.

- Proposal also assumes that COT would not have to pay costs of constructing a conveyance structure to return water to the lake. If COT paid for an assumed 5,000-foot-long, 30-inch-diameter pipeline to convey the water for the EPA treatment to the lake, the estimated construction cost would be about $0.5 million.

Additional Design/Investigative Work Required

Possibly the design of a conveyance structure to move extracted groundwater from treatment plant back to lake.

Conclusions/Recommendations

- This proposal is **recommended**.

- Need buy-in from EPA staff involved with the IBW-North and the IBW-South sites

- Must resolve potential effects on Rio Beach landfill.

- Tempe should pursue this proposal, concurrent w/ #3.
- #7 may not be allowed by ADEQ, ADWR, EPA.??

Proposal #8: Delete slurry walls and increase pumping rate to recover water.

Design Concept

Use a system of slurry walls and high-capacity infiltration management wells to prevent lake infiltration from affecting groundwater away from site.

V.E. Proposal

Do not build all of the proposed slurry walls and instead pump more water from the proposed (or additional) infiltration management wells to make up for increased infiltration losses.

Proposal contains four separate alternatives, as summarized below:

Alternative A: No slurry walls. Increase pumpage at upstream end to make up for deletion of upstream slurry wall. Do not attempt to capture additional infiltration losses at downstream end (due to deletion of downstream slurry wall) but get recharge credit for losses at downstream end.

Alternative B: No slurry walls. Increase pumpage at upstream end to make up for deletion of upstream slurry wall. Do not attempt to capture additional infiltration losses at downstream end (due to deletion of downstream slurry walls) but do not get recharge credit for losses at downstream end.

* **Alternative C**: Build slurry walls only around downstream end. Increase pumpage at upstream end to make up for deletion of upstream slurry walls. Close to original proposal.

Alternative D: No slurry walls. Increase pumpage at upstream end to make up for deletion of upstream slurry walls. Drill two additional wells at downstream end (each capable of pumping 4 mgd) to capture additional infiltration losses due to deletion of downstream slurry wall.

Advantages of Proposal

- Potential cost savings due to building fewer slurry walls
- More groundwater management flexibility (could allow more recharge if desired)

Disadvantages of Proposal

- Requires more pumpage and O&M costs (all four alternatives).

- Risky. Once the surface water source is turned off, it may be difficult to fill the lake and keep it full if lakebed infiltration rates are high (> 2 feet/day) and remain high for sustained period (all alternatives).

- Could have undesirable effects on Rio Beach landfill area (Alternatives A, B, and D).

- Need additional make-up water from surface water sources to account for uncaptured infiltration losses at downstream end (Alternatives A and B).

Unresolved/Unaddressed Issues:

- Can COT get recharge credits for infiltration losses at downstream end (Alternative A)? Is continual make-up water available to account for uncaptured infiltration losses at downstream end?

- How long can COT count on a continual surface water source to keep lake full if high infiltration rates are sustained?

- How could you obtain 8 mgd from two wells at downstream end where bedrock is typically less than 50 feet from ground surface (Alternative D)?

- Modeling predicts about *5 mgd* additional pumping will be required if the upstream slurry wall is eliminated, rather than the *3 mgd* figure noted in the proposal. May need an additional infiltration management well rather than simply increasing pumping rate of design team's proposed wells.

Estimated Construction Cost Savings

- Alternatives A, B, and D could result in about $11.6 million in construction cost savings if all the proposed slurry walls are eliminated. (However, Alternative D would add about $0.5 million in additional infiltration management well costs.)

- Alternative C of the proposal could result in about $5.8 million in construction cost savings if the upstream slurry wall was eliminated.

Additional Design/Investigative Work Required:

- No additional design/investigative work is required for Alternatives A, B, and C. However, if Alternative D is selected, a system would need to be designed to capture 8 mgd because the two proposed additional wells would not be able to capture that amount due to the shallow bedrock in the area.

Conclusions/Recommendations

- Must resolve potential effects of Alternatives A, B, and D on Rio Beach landfill.
- Need to pursue further agreement with SRP for assured water supply to keep lake full until infiltration rate decreases to where wells can keep up.
- Alternative C is the most promising alternative to reduce initial construction costs and still meet design criteria.
- COT needs to determine amount of risk they are willing to accept in terms of ability to keep lake full.

This proposal is **recommended**. It has the potential for significant construction cost savings. Although the V.E. team projected savings up to $11.6 million, we anticipate the savings will be closer to the Alternative C savings of $5.8 million. Additional costs may be required to address the above issues.

Proposal #9: Develop water-applied seal to prevent infiltration from lake.

Design Concept

Use a soil/bentonite slurry wall around the lake and recovery wells to controll water loss in the lake. During initial filling, install a tightly woven biodegradable geotextile to control seepage so the lake can be filled. In the long term , it is anticipated that the infiltration rate will be reduced.

V.E. Proposal

The V.E. team suggested developing methods for applying a low-cost soil seal on the lake bottom to minimize infiltration during initial filling of the lake and thus, eliminate the slurry walls and reduce the size of the infiltration recovery system. In the design concept, measures to reduce infiltration were discussed as a possible mitigation measure if infiltration rates exceed the pumping capacity of the recovery wells. It is anticipated that this will be a short-term condition and that eventually the infiltration rates will be reduced due to naturally occurring processes.

Advantages of Proposal

Slurry walls would be eliminated and the need for a infiltration recovery system reduced.

Disadvantages of Proposal

- This proposal will require experimental and developmental work to develop feasible methods of applying the soil sealing layer.
- There must be water in the lake to apply the proposed seal.

Unresolved/Unaddressed Issues

- Key elements of this proposal have not been tested and ultimately, may not be feasible.
- The local availability and costs of acquiring the silty soils needed for applying the infiltration layer may be grossly underestimated.
- If a high rate of recharge becomes a design element of the project or if significant natural sealing occurs, then the need for this proposal is eliminated.
- Acceptable to 404/401 Permit

Estimated Construction Cost Savings

The cost savings for this proposal result from the deletion of the slurry walls, geotextile, and reducing the number of pumping wells by one half. The only cost incurred is in obtaining and placing the soil. The costs used by the V.E. team assume a one mile haul distance for $3.50/cy and placement cost of $500,000. There is no material available within one mile of the site. The type of material described in the proposal is in high demande for local landfill closures and a long haul distance may be required.

Eliminate slurry walls	$	11,600,000
Reduce size of infiltration recovery system by 50 percent		1,100,000
Low-cost water-applied seal		1,800,000
Net Construction Cost Savings	$	12,700,000

HIGH

Additional Design/Investigative Work

This proposal would require additional work to conduct laboratory and pilot field studies so a methodology could be developed for applied the soil sealing layer.

Conclusions/Recommendations

The water-applied seal is **recommended** for further evaluation because of the potential for cost savings. The initial study looked at several low cost sealing methods that have worked in the past. A water-applied sealing method could be tested in conjunction with the test described in Proposal #11.

Proposal #10: Replace the upstream rubber dam with a sacrificial dam.

Design Concept

The proposed upstream dam is a 6-foot-high inflatable rubber dam. This dam is capable of being overtopped by up to 6 feet of water and lowered when the flows are greater. The dam can be reinflated after the flows pass, to create the lake again.

V.E. Proposal

The inflatable rubber dam could be replaced by a sacrificial earthen dam. The dam would provide the same functions as the inflatable dam except that it would need to be replaced after minor releases.

Advantages of Proposal

- Initial construction and life cycle costs are much lower than the inflatable rubber dam.
- The dam could be used as footpath to cross the river.
- An earthen dam would be less susceptible to vandalism than the rubber dams.

Disadvantages of Proposal

- The dam would need to be rebuilt after releases.
- After the sacrificial dam washes away, there could be the public perception of failure.
- It will take longer to rebuild the dam than to inflate the rubber dam. Would need an on-call contractor to rebuild quickly.
- There could be permitting issues to resolve.

Unresolved/Unaddressed Issues

- Permitting requirements for an earth embankment in the river.
- How often will the dam need to be re-built?

Estimated Construction Cost Savings

The construction of the sacrificial dam is approximately $500,000 as compared with $6,500,000 for the rubber dam foundation. If slurry walls are still required, a grade control structure would need to be built below the dam. If not, the slurry wall and dam foundation would need to be rebuilt each time the dam washed out. It would be difficult to reconstruct the slurry wall so the dam could be rebuilt in a short amount of time. The grade control structure would add about $1,000,000 to the construction cost.

Additional Design/Investigative Work

- Additional analysis and design of the sacrificial dam and grade control structure would be needed. The Bureau of Reclamation and the Nuclear Regulatory Commission Research have performed research on overtopping of embankments. The results of this research may provide the details for embankment construction.

- A model study of the embankment may be required depending on the hydraulic requirements of the dam.

Conclusions/Recommendations

Recommended; this proposal could result in significant construction cost savings. This proposal is dependent upon the City's criteria for how often and how fast the dam would need to be rebuilt.

- Volume - of materials (10,000 - 15,000 cy
- source?
- Raising WSB?

Proposal #11: Construct the project in phases.

Design Concept

The design concept provided for constructing the project in one phase. No additional investigations would be conducted during the construction phase.

V.E. Proposal

The proposed VE concept implements the project in the following phases so as to minimize the potential cost and risk of the project:

- Phase 1 would be to develop the lake bottom sealing criteria cost and rate of plugging to determine the most cost-effective means of adequately sealing the bottom to reduce the infiltration. Phase 1 would consist of both laboratory and field studies. Laboratory tests with water from the proposed source and several sand/silt slurry mixes would be conducted. Field studies would consist of a 10-foot-high vertical stand pipe to simulate the infiltration rate of a full lake and a 1- to 2-acre shallow pond to determine the rate of infiltration when sealed with a sand/silt slurry recommended from the laboratory tests. The laboratory and field tests would be conducted over a one-year period. (possibly 4 months).

- During Phase 2, a 3-foot-high temporary dam would be constructed across the river upstream of Rural Road and the sand/silt slurry mixture applied to the lake bottom to form the seal. Approximately 20 percent of the lake bed would be wetted. The purpose is to measure the effectiveness of the seal and the need for downstream slurry walls and/or recovery wells.

- Phase 3 would be the installation of the downstream dam and continuation of the sealing of the lake bottom in sections using the sand/silt slurry mix. Slurry walls and/or recovery wells would be installed, if necessary, in this phase.

- Phase 4 would be to construct (if necessary) the water quality improvement features, such as the stormwater diversions and installation of the upstream sacrificial dam.

Advantages of Proposal

- Defers construction costs
- Reduces risk
- Provides flexibility

Disadvantages of Proposal

- Increases investigation costs
- Delays filling the lake
- Requires additional construction contracts
- Facilities will be more susceptible to flood damage during construction
- Permitting may require revisions for investigations because of concern about adding material to the floodplain.

Unresolved/Unaddressed Issues

The V.E. proposal only focuses on the silt/sand slurry and windrow methods of sealing the lake. There may be other more cost effective sealing methods that should be investigated in Phase 1 and subsequently used in Phase 2. Phase 1 should be used to determine the best method to further investigate in Phase 2.

Additional wells may be required to maintain the water supply needed to run Phase 2. This cost was not included

The VE proposal assumes that the complete stormwater diversion system could be eliminated if water quality impacts are not as currently anticipated. However, because of hydraulic considerations, the full flow from the Mill Ave, Ash Ave, and Farmer Ave stormdrains will still require diversion downstream of the lake. Cost of this diversion piping is estimated at $_____.

The VE proposal recommended that a one year lab and field study be would be required. In reality, sufficient infiltration data may be obtained in a 4 to 6 month period.

In addition, the time required between Phase 3 and 4 is uncertain. Several years may be necessary to determine the water quality impacts of storm water discharges into the lake from either the Salt River, Indian Bend Wash, or the miscellaneous other storm drains.

Estimated Construction Cost Savings

Construction cost savings will depend upon what types of facilities are determined to be needed to control the lake seepage and water quality. Construction cost savings could range from $10,000,000 to $20,000,000.

Additional Design/Investigative Work

Additional design and investigative work (monitoring and sampling) would be required to conduct phases 1, 2, 3 and 4. Design work may be required for the infiltration basins and water supply. Additional investigative work would be required for preparing the lab studies, operating and monitoring the infiltration basins, sampling and analysis of the groundwater quality samples, and sampling and analysis of the stormwater and lake water quality.

Conclusions/Recommendations

Phasing of the project would provide additional data upon which to base the design of the infiltration management and stormwater diversion systems. These additional data could result in a less conservative design which, as a result, means lower construction costs that would greatly offset the higher design and investigative costs. However, filling of the lake could be delayed by 12 to 18 months. This proposal is **recommended** for further consideration.

Proposal #12:
Windrow the lake bottom to improve the lake bottom seal.

Design Concept

Windrow the lake bottom to improve the lake bottom seal. The proposed infiltration control system for the lake includes slurry wall and recovery wells.

V.E. Proposal

The slurry walls and wells would be replaced with a bentonite slurry seal on the bottom of the lake. The slurry seal is discussed in Proposal #9. This proposal further decreases the cost of the slurry seal by first windrowing the lake bottom.

Advantages of Proposal

V.E. team suggests that by windrowing the top 12 inches of the lake bottom, the cost of slurry sealing would be cut in half. This would be accomplished by stratifying the channel surface, bringing the cobbles to the top and the fines to the bottom.

Disadvantages of Proposal

- There are very few fines in the soils at the river bottom, and even less in the upper 12 inches.
- Covering a surface of irregular boulders will require more slurry than a smooth surface.
- This proposal is dependent on a slurry seal lake bottom providing effective infiltration control.

Estimated Construction Cost Savings

The V.E. team claims this will result in an additional $670,000 over the slurry seal alternative without windrowing. This savings depends upon using half the quantity of slurry seal as Proposal #9.

Additional Design/Investigative Work

Would require testing in a large onsite test cell, as described in Proposal #9..

Conclusions/Recommendations

Not recommended; do not believe slurry seal would be saved by windrowing. If Proposal #9 is selected, the windrowing method could be tried in one of the test cells.

Proposal #13: Replace two skimmer/aerators with air injection in the recirculation lines.

Design Concept

Replace two of the skimmers/aerators with air injection in the recirculation lines. The design concept includes four diffusers and four aerators/skimmers (towers) designed to increase the dissolved oxygen content of the lake water, provide a skimming action on the surface of the lake, and provide vertical mixing of the lake water. The proposed units are equally spaced along the length of the lake, each serving about 50 acres of the lake. Each diffuser/aerator/skimmer provides the energy to move 80 to 100 mgd of water.

V.E. Proposal

The proposed V.E. concept suggests replacing two diffusers/aerators/skimmers in the east end of the lake with air injection into the discharge of the recirculation wells. Since all the recirculation wells are located at the east end of the lake, the V.E. concept is limited to the east portion of the lake. The V.E. concept uses the same blowers used in the design concept, assuming an equivalent oxygen uptake efficiency and therefore equivalent power costs. However, by injecting air into the recirculation discharge piping, the tower structures and air diffusers in the lake are eliminated, in addition to the interconnecting piping. Vertical mixing by the units is replaced by the infiltration through the lake bottom to the recirculation pumps.

Advantages of Proposal

- Reduces in-channel structures that may require removal during high flow events
- Reduces cost
- Reduces risk to dam bladders if aeration structures were to break away from moorings and strike dam.

Disadvantages of Proposal

- Dependent upon infiltration through soil for mixing
- Reduces the skimming action on the lake.

Unresolved/Unaddressed Issues

Over time, a reduction in infiltration would reduce the amount of water available from the recirculation wells for aeration. In addition, the proposal does not directly address the need for mixing. The two diffusers/aerators/skimmers provide at least 200 mgd of water movement, which is projected to be required to prevent lake stratification. However, a separate circulation system (not dependent upon infiltration for lake circulation) could be used for aeration and mixing. This system would also need to be capable of moving up to 200 mgd of water.

The aeration system design is only at the concept stage. The degree of aeration/skimming required to maintain water quality will not be confirmed until after the lake has been filled and operating for some time. The method of how the structures will be moored in the lake and subsequently removed has not been determined.

Estimated Construction Cost Savings

$318,000

Additional Design/Investigative Work

Design of the well aeration system, and additional lake recirculation system (if necessary).

Conclusions/Recommendations

Since the degree of aeration and skimming required to maintain suitable water quality will not be known until after the lake has been constructed, it is recommended that the in-lake facilities for all four sets of diffusers/aerators/skimmers be constructed. The additional required facilities could be added later. Thus, the implementation of this proposal is **not recommended** until after the lake is operating.

Proposal #14: Alternative to edge treatment and shoreline modifications.

Design Concept

Alternative to edge treatment and shoreline modifications. The design concept for the shoreline treatment is to remove the top 12 inches of the existing CSA and replace it with cast-in-place concrete with a sand-blasted exposed aggregate finish. The cost opinion assumed that much of the CSA would be removed using hand-operated equipment rather than heavy machinery. The slope of the CSA would generally remain as constructed.

V.E. Proposal

The proposed V.E. concept also provides for the removal of the existing CSA but replaces it with precast concrete sections that are doweled into the CSA. The CSA would be removed by using a twin-headed grinder mounted on an excavator.

Advantages of Proposal

- Removing the existing CSA with specialized heavy machinery may provide time and cost savings. Removal techniques would be up to the contractor and not specified in the design.

- Precast sections may provide a more finished architectural surface than the cast-in-place concrete.

Disadvantages of Proposal

The slope variability of the existing CSA makes the construction of the precast sections much more difficult. (The design slope is 1.5:1, but it varies from near vertical to 2:1 in some places.)

Unresolved/Unaddressed Issues

The difficulty of removing the CSA is unknown at this time. To address the construction contractor's uncertainty concerning the required level of effort, it might be advisable to conduct a demonstration using a standard piece of heavy equipment to remove a section of CSA.

Estimated Construction Cost Savings

The V.E. proposal estimated that the cost opinion overestimated the cost of removing the existing CSA by $800,000. The use of precast concrete sections with dowels was estimated to cost $175,000 more than the design concept of cast-in-place.

Additional Design/Investigative Work

None anticipated.

Conclusions/Recommendations

Techniques for removing the CSA are at the discretion of the contractor and may include a combination of hand-operated equipment and heavy machinery. Cast-in-place concrete appears to be the most cost-effective method of providing the shoreline treatment. This proposal is **not recommended** for further consideration.

Proposal #15: Replace the Dorsey bypass with a stilling basin.

Design Concept

Replace the Dorsey bypass with a stilling basin. The design concept provides for a 1,600-foot-long, 54-inch-diameter pipeline that diverts first flush flows from the Dorsey storm drain and the design flow from the Karsten Golf Course drain to upstream of the upstream dam, thus reducing stormwater quality impacts on Town Lake.

V.E. Proposal

The proposed V.E. concept provides a phased approach. The initial phase replaces the diversion pipe with a stilling basin created by widening the existing open channel portion of the Dorsey storm drain. The stilling basin would provide for settling out of the pollutants. In the second phase, the developer would install the diversion pipe when the property is developed sometime in the future.

Advantages of Proposal

- Reduced costs
- Additional right-of-way would not be required.

Disadvantages of Proposal

Increased maintenance of removing the settled solids from the stilling basin

Unresolved/Unaddressed Issues

- A phased approach would allow time to measure the pollutant loading due to the Dorsey drain and determine whether a diversion pipe is necessary.
- Cost reduction depends upon being able to transfer costs of installing Dorsey diversion pipe to developers in the future.

Estimated Construction Cost Savings

$240,000

Additional Design/Investigative Work

Design of the stilling basin and related structures.

Conclusions/Recommendations

The phased approach to installing the Dorsey diversion appears to be well founded and is **recommended** for further consideration.