The Pool and its Infrastructure

Barton Springs Pool is nearly 1,000 ft. long. Its water surface covers nearly two acres.

The Pool is, of course, the centerpiece of the park and its reason to exist. The Pool we know today was built in the late 1920s with the construction of the two concrete dams across Barton Creek that still exist, creating nearly two acres of pool water surface. When it was built, the Pool captured the waters of Eliza Spring and the Main Spring, but the 1975 bypass tunnel diverted Eliza's waters. So today, except when flooding overtops the upstream dam, the Main Spring is the primary source of water for the Pool. It emerges from fissures in the exposed rock of the aquifer, just to the west of the diving board. Under non-flood conditions, all of the creek water is diverted around the Pool through the bypass tunnel.

From a hydraulic standpoint, the Pool acts as a pond, which means that its waters, in aggregate, move very slowly. Both swimmers and the endangered salamander prefer more stream-like conditions, therefore, improving the flow regime was identified from the beginning as an important goal of this master plan. Improving the flow regime is the scientific term for altering the way the water flows in the Pool for the better. To make improvements involves first studying the ways the water flows now, and then proposing adjustments to how and where the water enters and exits the Pool. It could also involve some methods for recirculating the waters within the Pool.

Barton Springs Pool under construction in the 1920s. C01818, Austin History Center, Austin Public Library.

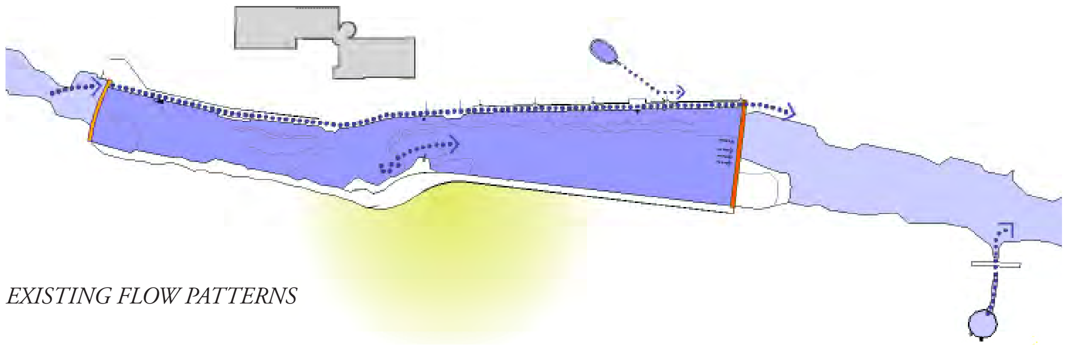
The goal of improving the flow regime comes from the observation that both salamanders and swimmers prefer clear, moving waters instead of the pond-like conditions that characterize parts of the Pool. Improving these conditions should be expected to at least partially address the nuisance algae problem, which accounts for the slippery bottom and the objectionable floating materials that are an ongoing problem, especially during conditions of drought.

Any proposal for altering the flow will have an effect on the salamanders, so proceeding with any course of action can only be undertaken after a thorough study has been concluded, determining the anticipated impact on water temperature, speed and direction. Many of the short-term recommendations for the Pool are components of this study.

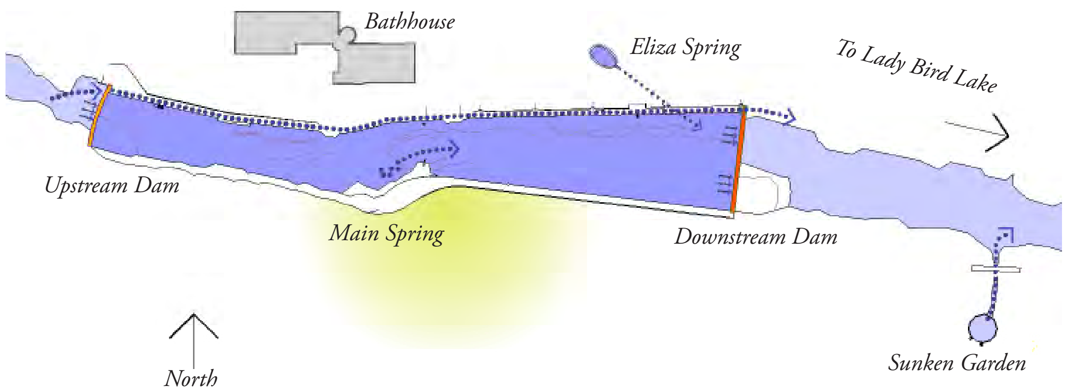
A related set of issues are those involving cleaning and maintenance of the Pool. Since flooding is a fact of life, procedures for cleaning up afterwards are critical to swimmer satisfaction (a faster, more thorough process is appreciated). And there are environmental considerations as well. Pool cleaning today involves the use of gasoline-powered equipment down in the Pool, a potentially dangerous proximity to the nearby salamander habitat. Electric equipment would be an improvement, so improved electrical infrastructure is a recommendation. And there are sustainability issues. High-pressure hoses are a part of the cleaning efforts, and they use City of Austin drinking water. As part of the larger city-wide effort to conserve water, new infrastructure for using Pool water for this purpose is recommended.

Yet another set of related issues involve structural deficiencies related to the bypass tunnel. The inlet grate is susceptible to clogging, which tends to block the bypass tunnel during floods, sometimes allowing even minor events to overtop the dam. The inlet grate should be replaced with an improved design. The structure of the bypass tunnel itself has also experienced deterioration over the years, especially at the joints. This should be addressed just to preserve the structural viability of the infrastructure, but it should also be addressed, because the leakage has water-quality implications for the Pool. In floods, turbid water leaks into the Pool from the bypass tunnel. And during droughts, Pool water escapes into the bypass tunnel--altering the flow regime in an uncontrollable way. The joints in the bypass tunnel should be repaired.

Since flooding occurs when waters overtop the upstream dam, possibilities for raising the height of that dam should be explored. At the same time, the width of the top surface should be widened if possible to facilitate equipment movement into and out of the Pool.



EXISTING FLOW PATTERNS

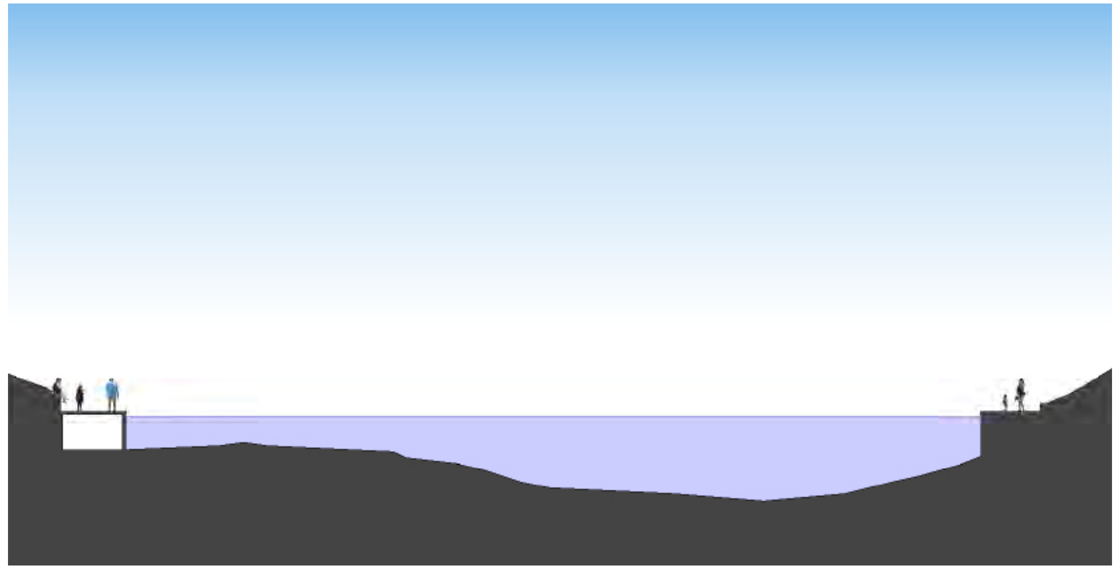


FLOW REGIME IMPROVEMENT CONCEPTS

One goal for this master plan is to improve the flow regime because both swimmers and the salamanders prefer more stream-like conditions over the pond-like conditions that characterize the Pool today. Except when floods overtop the upstream dam, the Main Spring is the primary source of water for the Pool. Conceptually, improvements to the flow regime might include creating new openings in the upstream dam, adding and relocating openings in the downstream dam and reconnecting the waters of Eliza Spring to the main body of the Pool.

Nuisance algae are an ongoing problem in the Pool, but they do tend to grow more vigorously in pond-like conditions, so they will tend to be more prevalent during a drought, when the spring flow may only be half of its normal output. Nuisance algae tend to break from the bottom and float during the heat of hot days, making it an especially disagreeable pest, since those are optimal times for enjoying the waters of Barton Springs. Nuisance algae also make the bottom of the shallow end slippery.

This section is based on bathymetry found in 'Barton Springs Pool Preliminary Algae Control Plan', by Alan Plummer Associates. It represents the Pool about 100 ft. from the downstream dam, and shows 1,350 sq. ft. of water in the cross section.



HYDROLOGICAL CHALLENGE

Flow rate in an open body of water is generally calculated as follows:

> *Water input (in cubic feet per second) ÷ the cross-sectional area = water speed.*

While flow rates at Barton Springs vary considerably,, we can use a normal rate of 50 cfs to illustrate the point:

> *50 cfs ÷ 1350 = .037 ft. per second. Interpretation: at 50 cfs, the waters of Barton Springs Pool generally flow at less than 1/2 inch per second (well below speeds that would move sediment, for instance).*

In some circumstances, allowing creek water to flow through can offer relief, but the creek is frequently dry, especially in drought conditions when the problem is even more acute.

IMPROVING FLOW REGIME

Adding and/or moving openings in the downstream dam or the wall of the bypass tunnel might play a role, but it is unlikely that they will offer a well-rounded solution by themselves, because directing flow to a particular location will necessarily be at the expense of the flow in another location.

Recirculating pipes offer promise as a partial solution. They would draw water from one part of the Pool and deliver it to another, from the Main Spring to the shallow end, for instance. While this can be effective, the technical challenges to moving sufficient water to make a meaningful difference could prove daunting.

Water bubbles are another concept, where compressed air is introduced at the Pool bottom, rising to stir the water, a concept generally understood from our common experience with fish aquariums.

Efforts to improve the flow regime are inspired, in part, to make conditions for nuisance algae less favorable; to allow the waters to run faster to create more stream-like conditions. But the dam and hydrodynamic engineers with whom the planning team consulted believe that it will take more than that to manage this problem, so efforts should be made to test the most promising possibilities for possible deployment on a permanent basis. And recognizing the ongoing issue, an algae skimmer should be installed along the south wall between the diving board and the downstream dam.

Recommendations

Many of the short-term recommendations of this plan involve initiatives to improve swimming conditions and salamander habitat conditions in the Pool. Some of them involve physical remediations (removing the gravel bar, for instance), some involve gathering additional information and studying more complicated remedies and still others involve changes intended to facilitate pool cleaning. Those recommendations fall into three categories, Water Quality Improvements, Water Quality Studies and Pool Cleaning Improvements.

WATER QUALITY IMPROVEMENTS

Remove Gravel Bar

Dammed waterways like the Barton Springs Pool tend to accumulate gravel and sediments in the lake, reservoir or pond created by the dam. Over time, this can significantly alter the vessel in terms of its depth, its temperature, its flow dynamics and its overall capacity, among other changes. At the Barton Springs, this process has resulted in an accumulation of an estimated 1,500 cubic yards of unwanted material (commonly called the gravel bar) in the deep end, resulting in significant loss of pool depth, an alteration of the flow regime and changes to the aquatic culture. Without action, this accumulation would likely continue to the extent that the viability of the Pool itself would eventually be compromised.

The most recent effort to remove it was undertaken in 2006, but, for technical reasons, it was not completed. The last successful removal operation took place in the early 1990s, prior to the official recognition of the Barton Springs Salamander as an endangered species. During that effort, with the water level lowered, trucks and heavy equipment were driven from the shallow end across the Pool floor to the deep end, a practice that would not be allowed today. Significant portions of the Pool are now considered Salamander habitat, and are off limits to heavy equipment.

Environmental constraints will not be the only challenges. The north sidewalk sits atop the bypass tunnel, and is not designed for heavy loads. Similarly, the south sidewalk may not be capable of handling heavy loads due to its poolside location, and the potential that

THOUGHTS ON THE EXISTING DAMS:

Modifications to the existing dams have good potential to improve the flow regime. The purpose of the hydrodynamic modeling is to determine which of the studied design alternatives will yield optimal improvements.

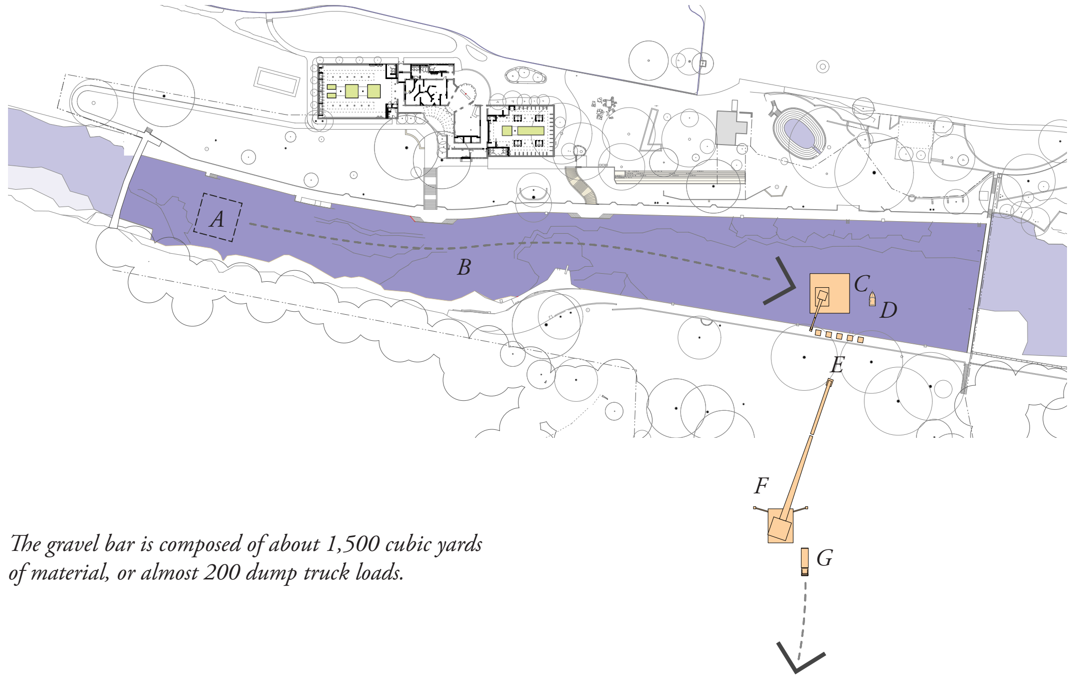
One obvious solution that should be contemplated is to reintroduce openings to the upstream dam. Historically the upstream dam had three openings, but those were closed in 1975 as part of the bypass tunnel construction. Since then, creek flow has been entirely eliminated from the Pool, except when flood waters overtop the dam. During certain conditions, the waters in the creek are as clean as the waters in the Pool (source: Watershed Protection staff). Running them through the Pool could be beneficial to plant or invertebrate species in the Pool, and assist with algae management.

New openings in the downstream dam could also improve flow conditions in the Pool. New gates in the lower reach of the dam could enhance self-scouring and cleaning along the bottom of the Pool, mitigating some sediment build up. At the same time, it is important to realize that dam engineers caution that operable gates are more susceptible to being jammed in the open position, the closer they are placed to the bottom. They also warn against excessive optimism regarding sediment scouring potential, generally suggesting that scouring will be most prevalent near the openings.

For the planning team, these observations serve as reminders that the hydrodynamic modeling/schematic design process will grapple with a complicated set of factors, and that proposals for change should be offered cautiously.

Remove Gravel Bar

- *A. Deploy barge-mounted backhoe in shallow end.*
- *B. Float barge across salamander habitat areas to deep end.*
- *C. Barge-mounted backhoe.*
- *D. Work boat.*
- *E. Filtration Hoppers.*
- *F. Land-based crane.*
- *G. Trucks.*
- *H. Booms and containment systems (not shown).*
- *I. Suction Dredge (not shown).*



The gravel bar is composed of about 1,500 cubic yards of material, or almost 200 dump truck loads.

its subsoil has washed out. Access to the Pool near Eliza Spring is also not acceptable for fear that the aquifer and the Salamander habitat could be compromised.

The sensitivity of the cultural context of this unique place must also be given appropriate respect. This must be an efficient process to minimize the time of Pool closure, but it must also acknowledge the fragility of the site. So some straightforward engineering solutions, like building a construction road across the South Lawn, are not recommended.

The process that appears to be most feasible is one that employs a barge-mounted backhoe and a land-based crane stationed on the flat portion of the South Lawn. The barge (with its backhoe) would be deployed in the shallow end of the Pool, then floated across the salamander habitat areas to the deep end. The barge would be serviced by a work boat. The backhoe would dig materials from the Pool and place them in a series of filtration hoppers located on the south walk. These loaded hoppers would then be plucked from their position at the edge of the Pool by the land-based crane and emptied into trucks at the top of the hill.

Aquatic turbidity curtains would be required to protect the water quality in the adjacent habitat areas. Additionally, if the backhoe is hydraulically driven, substantial secondary oil containment systems, including oil booms, would need to be to be installed. Furthermore, the composition of the removed materials may need to be tested to inform an environmentally responsible plan for disposal.

The backhoe process would remove all of the large material and much of the finer materials. This process would be followed by a suction dredging effort to finish the job.

The dredging effort described here is clearly expensive and time consuming, but it seems appropriate to the scale of the task. Once completed, more minor dredging can be undertaken on a more frequent basis to keep the size and expense of the task within more manageable bounds. This first effort is intended to mitigate 15 years worth of accumulation. If subsequent efforts are undertaken on a two to four year cycle, then the task can more easily be fit within normal pool maintenance efforts, such as the three week February cleaning period.

Of all of this Plan's short-term recommendations, this is the most aggressive. Removing 1,500 cu. yards of heavy materials from an aquatic environment in proximity to an endangered species habitat, all-the-while lifting those materials across a fragile landscape without damaging it, is no small task. While this master plan has sketched out this plan in broad terms, it should be designed in detail by a professional engineer. The environmental mitigation plan, including aquatic curtains and booms, filtration criteria, and debris and water disposition techniques should be designed by an environmental engineer. This work may require permitting from U.S. Fish and Wildlife and the Army Corps of Engineers among others. Furthermore, because this process is likely to take several weeks, efforts should be made to limit the area of disruption in hopes of keeping at least parts of the Pool open.

Replace Bypass Tunnel Inlet Grate

The bypass tunnel is the Pool's first line of defense against flooding. Ideally, it should divert minor flooding events, especially those of short duration, around the Pool preventing the silt, sand, gravel, rocks and debris normally associated with flooding from entering the Pool. However, as a practical matter, the ability of the bypass tunnel to flow to capacity is frequently impeded by clogging at the inlet grate. As a result, the Pool is easily flooded, resulting in Pool closings that could be avoided with a more efficient inlet.

The purpose of the inlet grate is to catch the kinds of large debris (such as tree branches) that might otherwise clog the tunnel, while also preventing public access. Not only does

The Pool has always required the occasional removal of gravel. Most of the practices traditionally used, like this horse-drawn drag sled in use in 1926, are no longer allowed.
PICA 20169, Austin History Center, Austin Public Library.


Existing inlet grate is damaged and clogs too easily.

this existing inlet grate clog easily, but it has also been damaged to the point that it allows the public to climb through the bent structural members and into the tunnel.

A new inlet grate should be designed that has the capacity to catch significantly more debris than the current design does, and to prevent public access to the tunnel. It should allow maintenance access, perhaps through a strategy as simple as unbolting certain structural members. The grate should also be designed with the aesthetics of the park in mind. As the "Crown Jewel of Austin", Barton Springs demands heightened attention to the visual character of all physical interventions, even those as mundane as an inlet grate.

Repair Bypass Tunnel Joints
The vertical construction joints within the bypass tunnel are exhibiting signs of distress, including cracking and spalling. The joints should be repaired to restore the concrete's integrity to provide adequate coverage over the reinforcing steel.

The cracked and spalling concrete should be removed to sound concrete and to such a depth to completely expose the first reinforcing bar parallel to the joint. The existing exposed reinforcing bar can be used to anchor the repair grout to the repair section without having to use anchors or dowels. A pumpable non-shrink, non-metallic grout can be used to restore concrete sections. The requirements for this work should be designed by an engineering team that includes a structural/civil engineer and an environmental engineer. The development of criteria for this work should reference the report, "Structural Assessment of the Barton Springs Pool Bypass Culvert" by PBS&J.

WATER QUALITY STUDIES
Pilot Studies for Water Recirculation at Beach
The Beach is the gravel area that runs parallel to the northern edge of the Pool from the downstream dam to roughly across from the diving board. The Beach is identified as a Salamander habitat, and efforts have been made to improve the population in this area, in particular by lowering the ground plane to make it less likely that salamanders would be crushed underfoot by wading swimmers. Despite these efforts, population counts generally reveal that very few salamanders live there. This pilot study is intended to determine whether water recirculation could be a viable technique to improve the flow regime in this area to make it a more amenable home to the salamander. The results will be used to help shape the hydrodynamic modeling efforts.

The study will be undertaken by Watershed Protection and Development Review Department staff using available equipment.

Pilot Study for Ultrasonic Algae Control

One of the primary goals of this master plan is to mitigate nuisance algae. New technologies using ultrasonic sound waves to kill the targeted organisms have shown promise in other installations. The literature suggests that these devices would be effective at killing just the troublesome single-cell algae while leaving other multi-cell organisms undisturbed. But questions remain.

Recognizing the ecological sensitivity of this habitat, a pilot study should be undertaken to test these devices in a limited area. Should the study yield successful results, a recommendation for a permanent installation may be forthcoming. The study will be undertaken by Watershed Protection and Development Review Department staff.

Pilot Study to Determine Effects of Creek Flows on Pool Water Quality

During certain times of year, the flowing waters in Barton Creek are as clean or cleaner than the waters that emerge from the springs themselves. This suggests that selectively introducing these waters into the Pool by means of controllable openings in the upstream dam might be part of a solution for improving the flow regime. In general, clear flowing water is good for the salamanders, and is not so good for nuisance algae.

While selectively (re)introducing creek waters to the Pool may seem to be an obvious positive, questions still remain as to its potential effects on the Pool ecosystem in general and the health of the salamander in particular. This pilot study intends to yield a better, though preliminary understanding of the effects of potential changes to water temperature, algae growth, flow regime and other criteria. It will be undertaken by Watershed Protection and Development Review Department staff using available equipment. The results will be used to help shape the hydrodynamic modeling efforts.

Topographic Survey

Accurate topographic information is essential to the success of the hydrodynamic modeling efforts. Clearly, the modeling can only be as accurate as the information it is based on. Because up-to-date topographic information does not currently exist, it will be commissioned at this time.

It will include the shape of the Pool bottom (bathymetry) and the grounds to the tops of the slopes (to understand hydrologic behavior during flooding events). It will include sufficient area upstream that might be flooded if the upstream dam were raised (one idea that is under consideration). It will include a sufficient area downstream to understand the consequences of various opening patterns in the downstream dam.

With water level down, gurgling leak in bypass tunnel is visible.

Hydrodynamic models can be physical scale models like this, or they can be numerical (computer) models. In slow moving waters, like those of Barton Springs, the sensors on a physical model are unable to make accurate detections.

Seizing this opportunity to commission a comprehensive survey, this topography should also establish benchmarks at both Eliza Spring and Sunken Garden. And to support a related effort, the South Woods should be surveyed to provide accurate topography for the design work on the proposed accessible route.

This work should be performed by a licensed professional surveyor. The scope should be prepared by the hydrodynamic modeling design team in consultation with Watershed Protection Development Review Department staff.

Flow (Hydrodynamic) Modeling

One of the primary goals of this master plan is try to find ways to positively alter the flow regime to improve conditions for the salamanders and to disrupt the growth of nuisance algae. An improved flow regime should also improve the experience for swimmers. Flow regime is the scientific term for the way water flows within a body of water. It involves more than simple water direction and speed, though that is part of it. It also involves understanding how water tends to stratify in terms of speed, direction and temperature. With this kind of detailed understanding, it is hoped that informed decisions can be made regarding impacts on salamander habitat, Pool ecology and nuisance algae.

From a hydrological standpoint, Barton Springs Pool is a pond because its waters, in aggregate, move quite slowly. For this reason, a numerical (computer) model, rather than a physical scale model, seems like the most practical approach. In slow moving waters, the sensors on a physical model are unable to make accurate detections.

The Pool is also a dynamic system. It experiences extended periods of drought as well as sudden flooding events. During drought, Barton Springs flow can drop to below 20 cu. ft./sec. During much of 2007, an especially wet year, flows above 100 cu. ft./sec. were not uncommon. During dry spells, because the flows at Eliza slow, its water level is kept up, in part, by the water pressure from the Pool. So draining the Pool (which is prohibited by the 10(a) permit during droughts) results in lower (threatening to the salamander) water levels in Eliza. There is much for the hydrodynamic modeler to consider.

This modeling is specialized work, and should be undertaken by hydrologists experienced in the nuances of these kinds of challenges (while there are others, the Utah Water Research Laboratory is a possible resource). The modeling should be undertaken in tandem with the efforts of a civil/structural engineer so that schematic design concepts for physical alterations can be tested as part of this effort. The team should also include a design component, so that ideas that may have visible implications (like a bubbling element in the shallow end,

One concept to be studied is the idea to add new openings to the downstream dam to improve the flow regime.

for instance) can be schematically designed. The team should also include an environmental engineer and an historical preservation specialist.

It is important to stress that the design concepts should not be confined to pre-determined ideas that involve alterations to the dams only. A better approach is one where the breadth of the inquiry is arrived at incrementally, so that the results of the first concepts tested would indicate the direction to pursue for the second concepts. This inquiry should be seen in wholistic terms and should account for recirculation concepts at both the beach and the shallow end. It may also involve the possibility of new openings in the bypass tunnel. And it should also account for the flow implications of the algae skimmer.

The recommendations for improving flow regime are difficult to gauge at this time, since their shape will be determined by the results of this modeling/schematic design process. Even still, it is worth reminding ourselves that Barton Springs is such an important icon for all of Austin, that any proposals for change should be thoroughly discussed with the public before action is undertaken. Therefore, this plan recommends that a public input process be included as an integral component of the design process that will follow the modeling, so that potential impacts can be well understood and digested over a period of time before long term commitments are made.

As a further safeguard for public sentiment, this plan recommends that this modeling/de-

Master Plan Values

The recommendations of this master plan are based on values believed to be important to this place and its history. In the case of the dams, there is both history and precedent involved. The plan's Goals Statement declares that additions and renovations should, "respect the fragility of this unique natural and historical setting", suggesting in this case that studies for improving the flow regime should exhaust all reasonable possibilities for using the existing dams before even thinking of new dam construction as a solution.

The upstream dam was built in the late 1920s with three openings in it for creek flow. These openings were closed during the 1975 construction of the bypass tunnel. One concept being considered is to install operable openings in the upstream dam.

sign process first study solutions that use the existing dams. After that, should the results of this effort suggest that more appropriate solutions can be found with more aggressive solutions, like replacing or relocating the dams, then the study process should be brought to a halt, and a process of public disclosure of study results should be undertaken. Only in light of clear public direction, should other alternatives be studied.

While this work will not directly result in construction work, it should certainly be expected that it might propose some. With this in mind, the modeling/schematic design team should consult with regulatory officials on the permitting implications of preferred solutions.

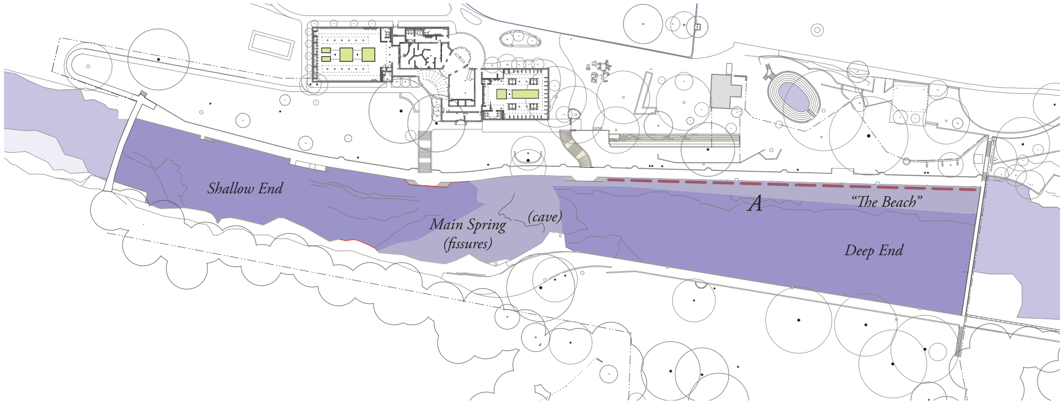
Structural Testing of Dams

One of the ideas that has coursed through this planning effort is that altering the pattern of openings in the dams could have a positive effect on the flow regime. This idea generally visualizes operable openings that can be adjusted as changing conditions demand. To take this idea beyond its current "concept stage" requires both a hydrodynamic modeling effort to test the hydrological results of the modification concepts, and a better understanding of the structural potential to add openings to the existing dams.

In 2006, both the upstream and the downstream dams were visually inspected by a professional engineer, whose report suggested that both dams appear to be in sound condition, and with proper maintenance, should have a long useful life left. Subsequent consultations with a dam engineer (part of this master planning effort) suggest that new openings could be made in these dams without compromising their structural integrity.

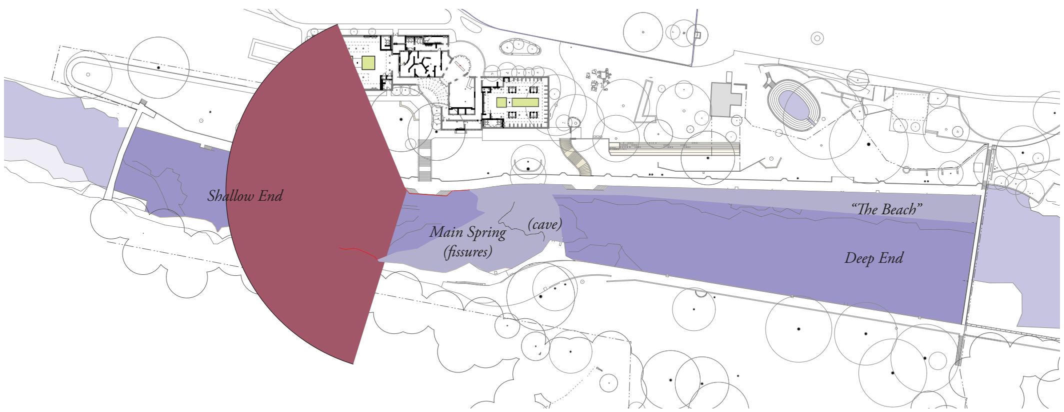
Both of these engineers' opinions are, of course, based on limited, visually-based information, so should not be taken as a final word. Structural testing of the dams is a logical next step.

Testing should take three vertical core samples through the each of the dams and into the bearing material below to determine the structural strength of the concrete and the friction between the dams and the ground they sit on. Because this work will generate turbid water and concrete dust, aquatic booms and absorbent pads will be required to soak up and contain water laden with concrete dust. The criteria for these core samples should be established by a structural/civil engineer. The samples themselves should be taken by a geotechnical testing laboratory, and the mitigation efforts should be designed by an environmental engineer. This work may require permitting from U.S. Fish and Wildlife and the Army



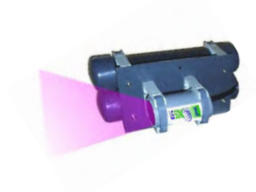
Water Recirculation at Beach

A. Recirculation Pipe. Assuming that the pilot study confirms the concept, the recirculation pipe would be used to improve the flow regime at the Beach.



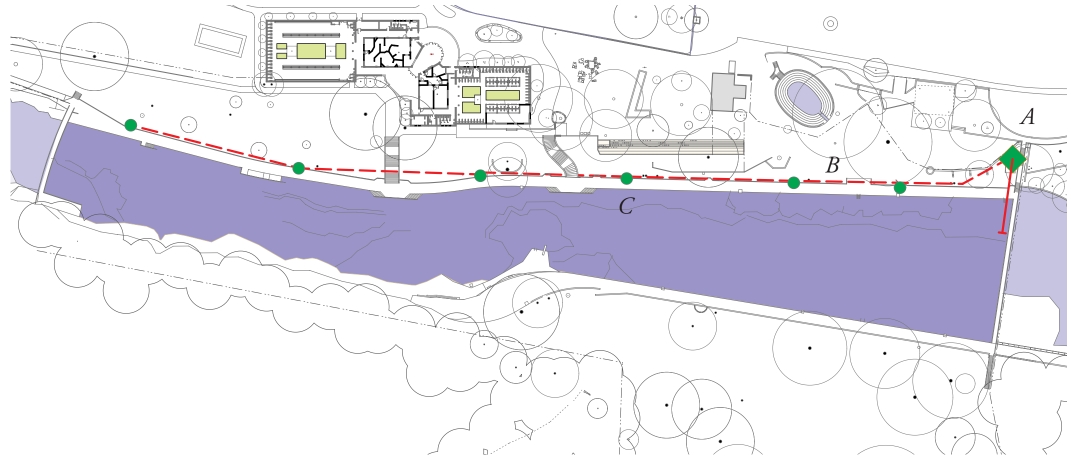
Ultrasonic Algae Control

A. Ultrasonic Algae Control. The device (about the size of a football) would be mounted to the wall of the Pool and pointed toward the shallow end.



Water Pump

A. Pump House.
B. Buried Water Pipe.
C. Typical Hose Coupling Device.



Corps of Engineers among others. It is likely that this work can be undertaken with only limited interruption of pool operations.

POOL CLEANING IMPROVEMENTS

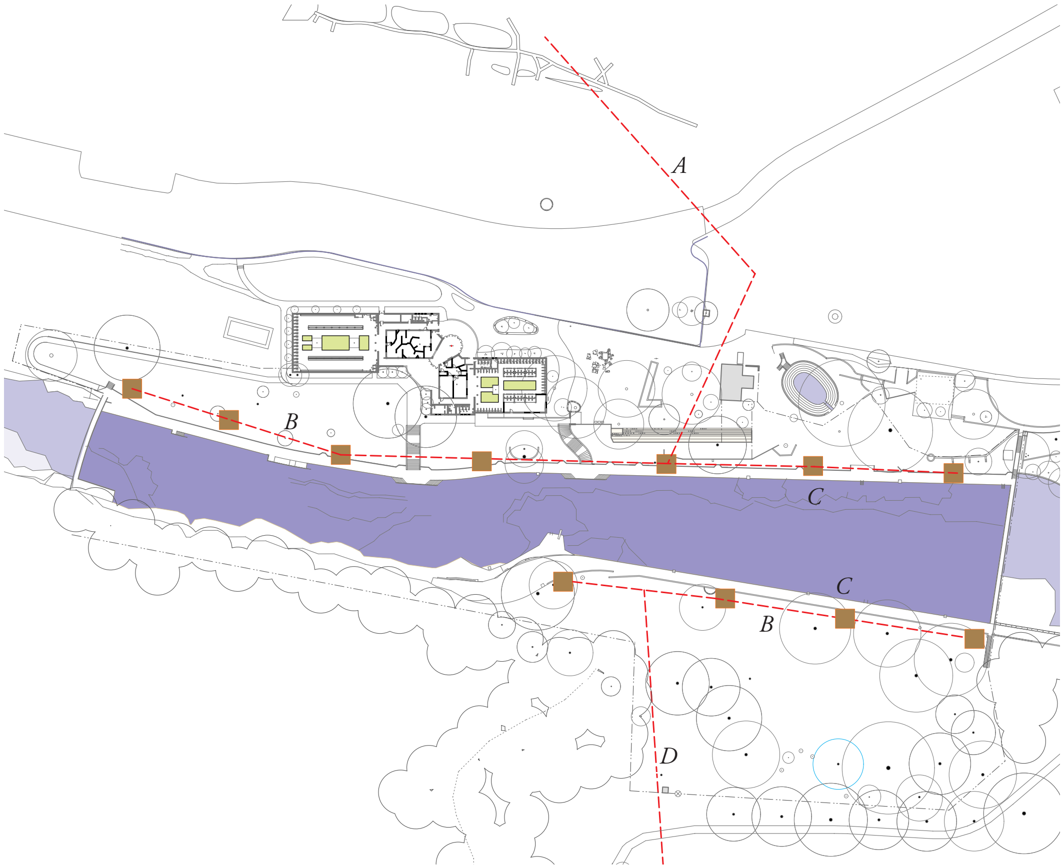
Additional Electrical Power at Pool Side

Most of the mechanical equipment used to clean the Pool today uses gasoline engines, which are notorious air polluters. But more to the particular circumstance of this place is the uneasy proximity of gasoline near a sensitive ecological zone. Electrical equipment would be an improvement, and the Aquatics Department could make the switch if sufficient power were available.

Additional electrical power should be brought to the Pool side to facilitate pool cleaning. An incidental benefit may be the eventual switch of lawn equipment to electrical. The work should be designed by a professional engineer, and should be coordinated with the initiative to remove all overhead lighting and the new site lighting being designed and installed by Austin Energy. It is likely that this work can be undertaken with only limited interruption of pool operations.

New Pump to Increase Water Pressure and to Facilitate Cleaning

Part of the routine pool cleaning activities includes the use of 2 ½" high-pressure fire hoses to clean certain areas. City of Austin drinking water is currently used for this process, because the City system is capable of achieving the required pressure and volume. Unfortunately, when one hose is in use, pressure losses elsewhere in the park make it difficult to flush toilets in the Bathhouse. When two hoses are in use, pressure losses affect plumb-



Site Electrical

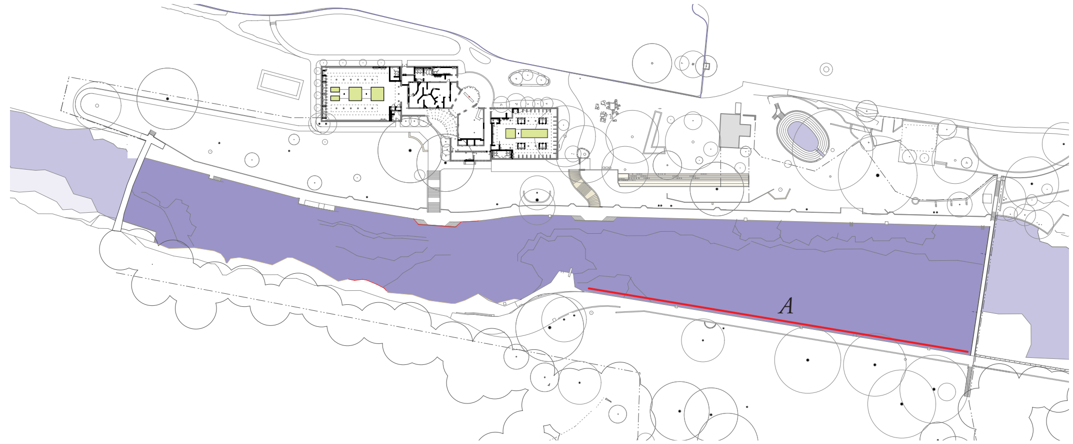
A. *Future underground electrical service to Zilker Ponds (long term goal).*
B. *Buried site electrical.*
C. *Typical electrical device.*
D. *Underground electrical service from Robert E. Lee.*
E. *Coordination with new lighting by Austin Electric (not shown).*

ing fixtures as far away as the McBeth Recreation Center. Pool water would generally be a better source for this process if the pumping infrastructure were in place. Pool water is also better environmentally, because it does not contain chlorine. Furthermore, it is a more sustainable approach for a city where water use demands are an increasingly serious matter.

A new pump should be installed to accommodate the high-pressure cleaning requirements of the Pool, and it should be sized to allow two or more hoses to be operated at once. It should draw its water from the deep end. Piping should be installed underground along the northern edge of the Pool so that hose fittings can be located in the surface of the existing retaining wall at intervals convenient for the cleaning process. The system should be arranged so that the pump can be used to pressure assist the use of City water during those

Algae Skimmer

A. Algae skimmer on south wall.



Trash pump used for silt disposal.

times when the Pool water is not suitable for use in cleaning (like immediately after a flood when the water is too turbid).

The pump should be located in a new pump house at the northeast corner of the Pool grounds. This work should be designed by a professional engineer, and its requirements should be coordinated with appropriate regulatory agencies including the City's Watershed Protection and Development Review Department. It is likely that this work can be undertaken with only limited interruption of pool operations.

Algae Skimmer

An algae skimmer should be installed along the south wall between the diving board and the downstream dam. The skimmer should be designed by a civil engineer, and it should be tested as part of the hydrodynamic modeling process to understand its flow regime implications prior to deployment.

Disposal for Silt and Nuisance Algae

Cleaning the shallow end of the Pool after a flood currently involves hosing the accumulated silt, sediment and debris to a temporary holding area created by silt fence. The silt laden water is pumped into a nearby deck drain with a trash pump. This practice has been cited in more than one annual report to U.S. Fish and Wildlife as a non-compliant practice along with the comment that a practical, compliant solution has not been found.

This plan recommends that an environmental engineer be commissioned to design a disposal process that complies with TCEQ and other applicable standards. While the terms of this design are yet to be determined, it may be worth noting that one standard practice for managing turbid water in environmentally sensitive areas such as this is a dewatering bag. An environmental engineer generally designs the filtering criteria for these bags. Assuming that the dewatering bag is the engineer's preferred solution, their purchase for staff use should be included in this recommendation.

While the disposal practices for brush and debris (add it to the park brush pile) seem appropriate, these, too should be reviewed by the environmental engineer.

Collected algae has been identified as a particular problem, since it tends to rot if left to dry in a pile. This algae should be composted on-site near the "brush pile" by Parks Department gardening staff using available tools and equipment. This seems practical since the quantities are too small to require trucking it to an off-site location. The finished compost should be used to fertilize plants near the Bathhouse. Composting techniques can be learned through the Compost Advisory Council.

Design Opportunities

The general speed of water through the Pool is a function of the amount of water that exits at the springs and the volume of the Pool. Since the amount of water discharging is not fixed by Pool infrastructure, the width and depth of the Pool are factors that could be adjusted. This could result in concepts that narrow the Pool in places, or make it shallower in others; all in the interest of speeding the flow of water.

Also related to the speed of water is the idea of recirculating water within the Pool. This idea involves drawing water from one area and pumping it to another. For instance, it might involve drawing water from the diving well and pumping it to the shallow end. If this idea emerges, it would offer a design opportunity to introduce stonework into that part of the Pool, which would make it look more natural. With skill, new stonework could mask some of the manmade appearance of the side of the bypass tunnel and recapture some of the "old swimming hole" character that was lost during that construction effort.

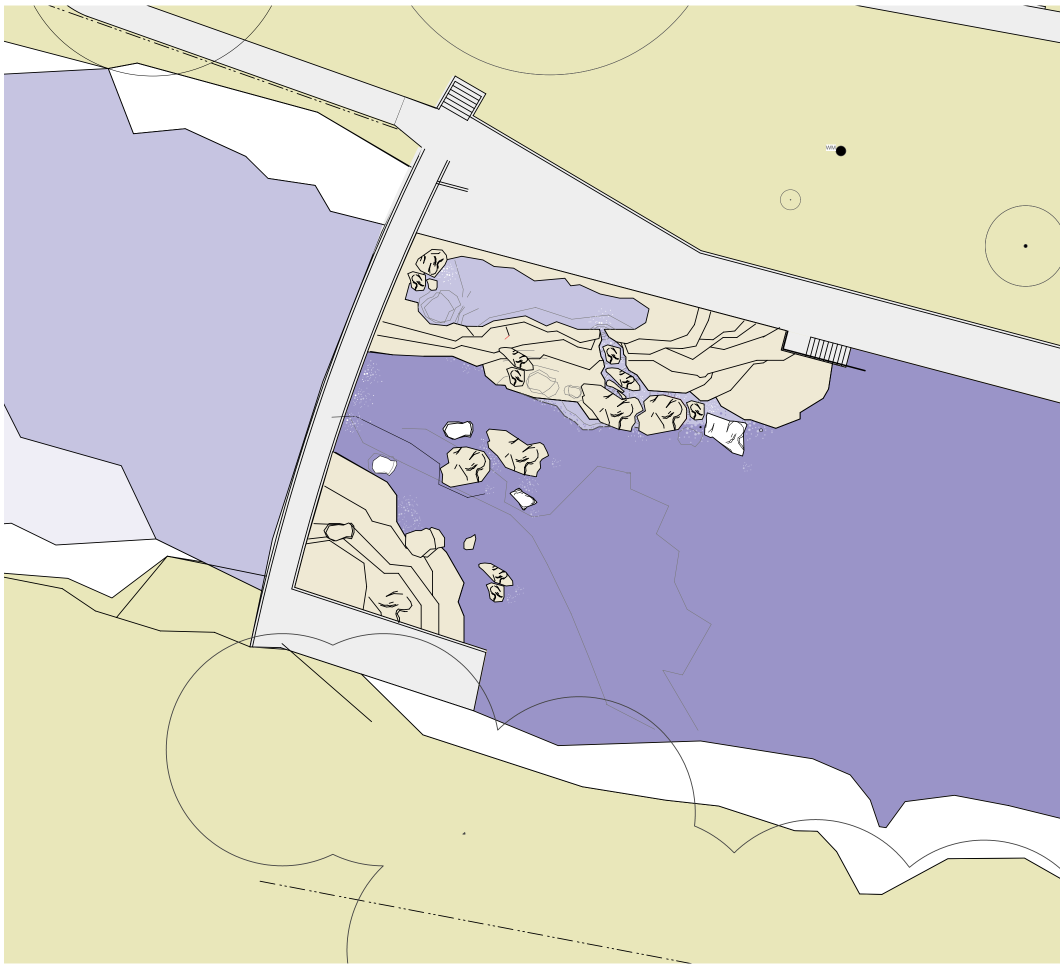
Even while we consider design opportunities preliminarily, it is worth reminding ourselves that Barton Springs is such an important icon for all of Austin, that any proposals for change should be thoroughly discussed with the public before action is undertaken. Therefore, this plan recommends making a public input process an integral part of the modeling/design process, so that potential impacts can be well understood, and digested over a period of time before any long term commitments are made.

It may also be worth reminding ourselves that the recommendations of this plan are built on a Goals Statement that articulates the value of both the historic and the natural ele-

In the 1920s, the shallow end featured a more natural edge characterized by boulders and informal plantings. C01824, Austin History Center, Austin Public Library.

While the bypass tunnel did, indeed accomplish its goal of mitigating some flooding, it did so at the expense of the Pool's character. This is especially pronounced in the shallow end, where the tunnel is tallest and its wall is most exposed. Ideas such as water recirculation, that may emerge from the hydrodynamic modeling/schematic design process should be seen as opportunities to create new stone elements that might mask some of the tunnel's manmade character with more naturalistic materials and forms.

ments of this place. Therefore, this plan recommends that the historic dams themselves should be thought of as valued parts of the iconography of the place, and should be preserved if possible, even if new openings are made. To that end, this plan recommends structural testing of the dams to confirm their viability into the future. Furthermore, it recommends, as a safeguard for public sentiment, that this modeling/design process first study solutions that use the existing dams. After that, should the results of this effort suggest that more appropriate solutions can be found with more aggressive solutions, like replacing or relocating the dams, then the study process should be brought to a halt, and a process of public disclosure of study results should be undertaken. Only in the light of clear public direction, should other alternatives be studied. And if other alternatives are to be studied, this plan recommends including the possibility that no changes at all should be made to the dams to the considered alternatives.



DESIGN OPPORTUNITY

Among the numerous possibilities for improving flow regime, one that might be explored is to recirculate water by pumping it from a deep area and releasing it in another area in need of improved flow. The shallow end, because it is upstream of the Main Spring would seem to be a likely candidate for this kind of improvement. If the hydrodynamic modeling bears this out, then it would offer design possibilities that do not currently exist. This sketch suggests that an accumulation of stonework be built against the wall of the bypass tunnel so that the top of the stonework is level with the Pool deck. A shallow depression is created, and the recirculated water is poured into it, creating an easy-to-reach water feature for small children. That water then spills through rivulets down to Pool level.

This idea begins with a straightforward engineering concept and combines it with the observation that the shallow end is the least attractive part of the Pool, and the substantial level change from deck to Pool make it difficult to access, especially for families with small children.

This idea could pay even further flow-regime dividends if openings are restored in the upstream dam, because it would narrow the channel there, making the water run more swiftly.

Short Term Projects

From the beginning, one of the goals of this master plan was to identify a collection of short-term projects, and present them to the City Council for funding in the 2007-2008 budget cycle. And that was, indeed, done when 21 projects were presented to and funded by Council in September of 2007. Those projects were chosen on the basis of several criteria:

Public safety.
The roof replacement for the Bathhouse and the evaluation of certain existing trees are two projects with public safety components.

Preliminary steps to a larger goal.
The topographic survey, structural testing of the dams and the hydrodynamic modeling are all required information-gathering steps leading to a larger goal--actually making flow regime modifications to the Pool.

Projects with separate funding sources.
Austin Energy agreed to fund the replacement of site lighting and to make electrical upgrades around the Pool. And the Watershed staff agreed to undertake three pilot studies using available resources.

Projects agreed to by consensus.
A proposed list of short-term goals was developed, in part, through a public participation process, where the planning team learned that there was a general preference for seeing water quality improvements as soon as possible. This list was refined through additional public participation. Many of those projects were agreed to by consensus.

Projects that support City of Austin values.
The accessible route in the South Woods is one project that satisfies a City value; to be an accessible community.

The short term projects were grouped into five categories:

Water Quality Improvements

- Remove Gravel Bar
- Replace Bypass Tunnel Inlet Grate
- Repair Bypass Tunnel Joints
- Renovate Sunken Garden (part 1)

Water Quality Studies

- Topographic Survey
- Hydrodynamic Modeling
- Structural Testing of Dams
- Pilot Study for Water Recirculation at Beach
- Pilot Study to Determine Effects of Creek Flows on Pool Water Quality
- Pilot Study for Ultrasonic Algae Control

Pool Cleaning Improvements

- Additional Electrical Power at Pool Side
- New Pump to Increase Water Pressure and to Facilitate Cleaning
- New Algae Skimmer
- Disposal for Silt and Nuisance Algae

Grounds Improvements

- Tree Assessment and Treatment
- General Grounds Improvements
- New Accessible Route on South Side
  Evaluate Existing Accessibility Improvements on the North Side

- Interpretive Plan

Building

- Rehabilitate Existing Bathhouse (phase 1)

IMPLEMENTATION

WATER QUALITY IMPROVEMENTS

Remove Gravel Bar

Because removing the gravel bar is such a serious challenge, it should only be undertaken with a professional engineer in charge and an environmental engineer to consult on mitigation criteria and to coordinate permitting efforts. A landscape architect may be required to lead the site restoration efforts, to repair damage to plantings that might occur during the course of the work.

In addition to writing the proposal, a significant aspect of this project will be the administration of the gravel removal contract during the removal operations. The downstream dam must be protected, environmental controls (booms, etc.) must be kept secure, load constraints on the south walk must be respected, the South Lawn must be protected and the site must be restored as the work is finished. All of this work should be administered by the engineer of record.

Efforts should be made to undertake this work during the normal Pool cleaning period in February. Even so, it will take longer than that to execute, so it will be a disruption to normal Pool operations. For this reason, and for reasons of effective Pool administration policy, the public should be kept informed on its progress.

New Algae Skimmer

Since a new algae skimmer as long as the one under consideration will have flow-regime implications, its effects should be confirmed through the efforts of the hydrodynamic modeling effort

Replace Bypass Tunnel Inlet Grate

For the most part, this is a stand-alone task. It does not rely on the completion of any other tasks as a precondition for proceeding, although it may be preferable to do this in coordination with the bypass joint repair work. This work can and should begin promptly. This work should be jointly led by a civil engineer, experienced in working in environmentally sensitive areas, and a design professional, either an architect or a landscape architect. This unusual team composition is recommended to acknowledge the fact that this element has both a functional and an aesthetic component. The design professional should be counted on for graphic depictions of design proposals.

Water Quality Improvements Estimated Costs

Remove Gravel Bar	*905,600*
Replace Bypass Inlet Grate	*233,478*
Repair Bypass Tunnel Joints	*285,362*
Renovate Sunken Garden (part 1)	*278,495*
Subtotal	*1,702,935*
Contingency (25%)	*425,734*
TOTAL	*$2,128,669*

These estimated costs include construction costs, professional fees, administrative and soft costs and a factor for price escalation.

Because this is a rather small task, it may be cumbersome to administer. So the City may choose to bundle it with other, larger efforts for administration efficiency. In that case, it may want to add it to the scope of the hydrodynamic design team.

Repair Bypass Tunnel Joints
This is a stand-alone task. It does not rely on the completion of any other tasks as a pre-condition for proceeding, although it may be preferable to do this in coordination with the bypass inlet grate work. This work can and should begin promptly.

While this task is likely to take a number of months, most, if not all of this work will be accomplished from inside the tunnel. Nonetheless, the required drawdowns may impact the operation of the Pool. The swimming public will likely be interested in understanding the project. So the consultant, together with City staff should anticipate a need to report on progress as required.

Because this is a rather small task, it may be cumbersome to administer. So the City may choose to bundle it with other, larger efforts for administration efficiency. In that case, it may want to add it to the scope of the hydrodynamic design team.

Renovate Sunken Garden (Part 1)
This plan recommends renovating Sunken Garden in two parts, with the first part concentrating on the spring vessel, the spring run and the next wall in the concentric series. The second part should concentrate on the renovation of the remainder of the walls. Because it is important that both renovation efforts be coordinated, even if they are separated by an interval of time, the remediation strategies for the masonry restoration for the entire complex should be designed in Part 1.

The renovation of Sunken Garden should be led by an architect experienced in historic preservation. The team should include a structural engineer (for the walls), a civil engineer for grading and drainage issues, a dam engineer for the operable gate and a landscape architect. Because significant salamander biology efforts are already underway, the team should work to coordinate with them, and should rely on City Watershed scientists for habitat expertise. Even so, if unanticipated mitigation requirements present themselves during the design process, an environmental engineer should be included on the team.

The permitting requirements for this effort are not entirely clear at this time. Nonetheless, the team should anticipate consulting with U.S. Fish and Wildlife Service and City Watershed Protection and Development Review Department regulatory staff. And because this is a historic site, the team should anticipate a review by the Texas Historical Commission and the City Historic Preservation Office will be required.

Part 2 should be seen as a continuation of the work of Part 1, and should be undertaken by a similarly composed team.

WATER QUALITY STUDIES

Topographic Survey, Hydrodynamic Modeling, Structural Testing of Dams, Pilot Studies

The topographic survey, hydrodynamic modeling and structural testing of the dams are three components of a larger effort to improve the flow regime in the Pool. Since they are so related, these efforts should not be separated into individual tasks, but should be coordinated by one team of professionals, the hydrodynamic design team. The new skimmer design is proposed to eliminate nuisance algae, but it will require water flow to operate, so it will have a flow-regime consequence, so it should be included, too. Significantly, all of this work will be influenced by the results of two proposed pilot studies: the study for water recirculation at the Beach and the study to determine effects of creek flows on water quality. While these studies are related to flow regime questions, they need not be the work of the hydrodynamic design team. Indeed, they should be the work of the City Watershed Protection and Development Review staff.

It is important to stress that the hydrodynamic design team should be looked to for structural and hydrological concepts. But they are not scientists trained in the nuances of stream ecology, and should, therefore, not be expected to make judgements on matters of ecological impact. Those should be made by a scientific team formed for the purpose of providing leadership on these matters.

The recommendations that emerge from the hydrodynamic design efforts will likely impact the Pool in many ways, subtle and profound, from adjustments to the flow regime (obviously), to construction closures, to design changes (recirculation at the Beach, for instance). Because the public will have a keen interest in any changes, a mechanism for public involvement should be included in this process.

This work should flow as follows:

1. City Watershed staff should conduct Pilot Studies, with results communicated to hydrodynamic design team.
2. A scientific team should be created whose charge is to provide scientific leadership and advice to this project. This can be any combination of in-house City Water-

Water Quality Studies Estimated Costs

Pilot Study for Water Recirculation at Beach	**
Pilot Study for Ultrasonic Algae Control	***
Pilot Study to Determine Effects of Creek Flows on Pool Water Quality	**
Topographic Survey	*106,275*
Hydrodynamic Modeling and Dam Design	*250,809*
Structural Testing of Dams	*141,700*
Subtotal	*498,784*
Contingency (25%)	*124,696*
TOTAL	*$623,480*

These estimated costs include professional fees, administrative and soft costs and a factor for price escalation.

*** These costs are not enumerated here, because the work is being done by Watershed's own forces.*

**** This cost is not enumerated here, because Watershed intends to pay for the ultrasonic device with available funds.*

shed expertise or outside consultants. It will likely include City Watershed engineers, geomorphologists experienced with fluvial processes and other professionals as may be deemed appropriate and necessary.

3. The scientific team should establish the goals for the modeling exercise that should include flow, temperature and other relevant criteria.
4. The hydrodynamic design team should write proposal criteria for a topographic survey. City of Austin should commission the survey.
5. With the topographic survey in hand, the hydrodynamic design team should write a proposal for a flood study. City of Austin should commission the study.
5. The hydrodynamic design team should write proposal criteria for structural testing of dams. City of Austin should commission the testing.
6. The hydrodynamic design team should install temperature and vector sensors in the Pool to gather information on temperature stratification and flow direction, as may be appropriate.
7. Using the gathered information and working with the criteria developed by the scientific team, the hydrodynamic design team should test flow regime improvement concepts. Concepts should include flow-regime impact of skimmer. Results should be evaluated by the scientific team, so that modified concepts can identified and tested as required.
8. At regular intervals, and as promising concepts are developed, the public should be informed, and public input should be sought.
9. Final recommendations should be published in anticipation of future implementation funding. If, however, results are inconclusive or if they point to the need to replace dams, the public should be informed, and—with significant public input—a full range of options should be explored.

HYDRODYNAMIC DESIGN TEAM
Team Leader
A professional engineer with special expertise in dam design. This individual should coordinate the efforts of others within the team, and should be the chief author of engineering-findings.

Hydrodynamic Modeler
A hydrologist with special expertise in flow-regime modeling. The model should be capable of analyzing flow speed and direction, the influence of insolation (sun heat), the influence of wind and the influence of temperature differences across the cross section.

This professional is likely to be found at a nationally recognized modeling laboratory, such as the Utah Water Research Laboratory.

Design Professional
An architect or a landscape architect to interpret potential impacts on the physical experience of the Pool. Their work could include graphic depictions of proposals. And if concepts emerge that suggest a new built feature (like a bubbling element in the shallow end, for example), the design professional should design it.

Environmental Scientist
An engineer experienced in mitigating environmental impacts of construction projects in environmentally sensitive circumstances. This individual should be experienced in the regulatory requirements associated with such projects.

PILOT STUDIES
Pilot Study for Water Recirculation at Beach
This is a stand-alone project to be conducted by City Watershed staff, and is intended to generate useful design criteria for the hydrodynamic modeling team and its scientific team. The results of this project should be integrated with the preliminary calculations on this same topic that can be found in Appendix B, Consultant Reports. Since this project is to be undertaken with City Watershed's own forces, no money was budgeted for this task.

Pilot Study to Determine the Effects of Creek Flow on Water Quality
This is another stand-alone project to be conducted by City Watershed staff, and again, it is intended to generate useful design criteria for the hydrodynamic modeling team and its scientific team. Since this project is to be undertaken by City Watershed's own forces, no money was budgeted for this task.

Pilot Study for Ultrasonic Algae Control
This is a third stand-alone project to be conducted by City Watershed staff. It is intended to verify that ultrasonic algae control technology is effective in the control of nuisance algae and that it is harmless to beneficial plant and animal life. The results of this study will be used to determine if this technology is suitable for being deployed in the Pool on a permanent basis. The device to be tested will be purchased using City Watershed operating funds, and the tests will be conducted by City Watershed's own forces. Therefore, no money was budgeted for this task.

Long Term Projects

In addition to the short-term projects, another goal of this master plan was to identify long-term projects. The short-term projects were funded by the City Council in 2007, and are on their way to implementation, but the long-term projects are not funded, so their implementation trajectory is less clear. And, because they vary in terms of cost and complexity, their trajectories will vary from project to project. But even in the face of these uncertainties, implementation is discussed here as a way of fostering an understanding of the kinds of challenges--scheduling, funding, professional resources--each project might require, hoping that a clearer picture will assist the process of one day making each project a reality. To understand how and when long-term projects may be undertaken, it may be useful to understand them in terms of three general sets of constraints and opportunities:

Projects awaiting clarification.
Projects relating to improving the flow regime fall into this category, since even their scope will be determined by studies undertaken as short-term projects. Similarly, the rehabilitation of Eliza Spring awaits progress (when and if it happens) in improved habitat conditions and greater salamander population at Sunken Garden.

Projects that might be broken into phases.
Landscape projects lend themselves to being tackled in parts. And they even lend themselves to different project delivery methods; hiring professional landscape contractors, performing the work with Parks Department landscape forces, or using volunteer forces.

Projects awaiting funding.
Rehabilitating the existing Bathhouse (part 2) is a good example as is the construction of a new south bathhouse. Each of these are stand-alone projects, and each should be done in a single effort.

The long term projects can be grouped into four categories**:

Water Quality Improvements

- Flow Regime Improvements
- Renovate Eliza Spring
- Renovate Sunken Garden (part 2)

Grounds Improvements

- Rehabilitate Zilker Ponds
- "Dog Park" Improvements
- Further Downstream Improvements
- General Grounds Improvements, North Side
- Grounds Improvements, South Side

Building

- Rehabilitate Existing Bathhouse (part 2)
- New South Bathhouse

Projects by Others ***

- Complete the Zilker Trail
- Relocate the train tracks
- Convert Maintenance Yard to New Function
- Build New Restroom/Concession Stand North of Playscape
- Build New, Smaller Concession Stand in Tree Court
- Grounds Improvements at Drives near Robert E. Lee

*** The use of categories can be tricky, because some projects fall into more than one. Renovating Eliza Spring, for example, is a water quality improvement, but it is at the same time a grounds improvement. Even so, for purposes of establishing some order, they have been assigned to the category that seems to define them best.*

**** These projects are listed here even though they are beyond this scope, because they are mentioned in the text of the master plan, and because they, generally speaking, complete the logic of the plan. They will not be further elaborated in this chapter, but by listing them here, it is hoped that they will not be forgotten.*

WATER QUALITY IMPROVEMENTS

Flow Regime Improvements

Discussing flow regime improvements in any detail is impossible at this time, because even the act of making these recommendations awaits the results of hydrodynamic modeling studies yet to be undertaken. Even still, anticipating that they might include some combination of installing new operable openings in the dams, and some water recirculation, it is reasonable to suppose that the team should be led by a civil engineer experienced with water impoundment issues and in mitigating environmental impacts of construction projects in environmentally sensitive areas. And it should include a design professional, either an architect or a landscape architect. This unusual team composition is recommended to acknowledge the fact that these improvements are likely to have both functional and aesthetic components. The design professional should be counted on for graphic depictions of design proposals.

These kinds of improvements will almost certainly require permits at the federal level from U.S. Fish and Wildlife Service, the Army Corps of Engineers, as well as permits at the state and local levels. And since these kinds of improvements strike at the very core of the place, a process for soliciting public input should be anticipated.

Renovate Eliza Spring

Renovating Eliza Spring involves a collection of tasks spread across a number of disciplines. The reconstruction of the spring run will involve civil engineering and landscape architecture as well as stream ecology specialists. The removal of concrete and stone from the amphitheater will involve an architect with experience in historic preservation as well as a civil engineer. And the construction of new landscape steps, paths and walls will involve an architect or landscape architect. The new plant materials will, of course, involve a landscape architect. This project also anticipates an interpretive planning component, so specialists in that discipline should be made a part of the effort. And a plan for an appropriate public participation process should be anticipated.

Renovate Sunken Garden (part 2)

This plan recommends renovating Sunken Garden in two parts, with the first part concentrating on the spring vessel, the spring run and the next wall in the concentric series. The second part should concentrate on the renovation of the remainder of the walls and surrounding landscape. Because it is important that both renovation efforts be coordinated, even if they are separated by an interval of time, the remediation strategies for the masonry restoration for the entire complex should be designed in Part 1.

Water Quality Improvements Estimated Costs

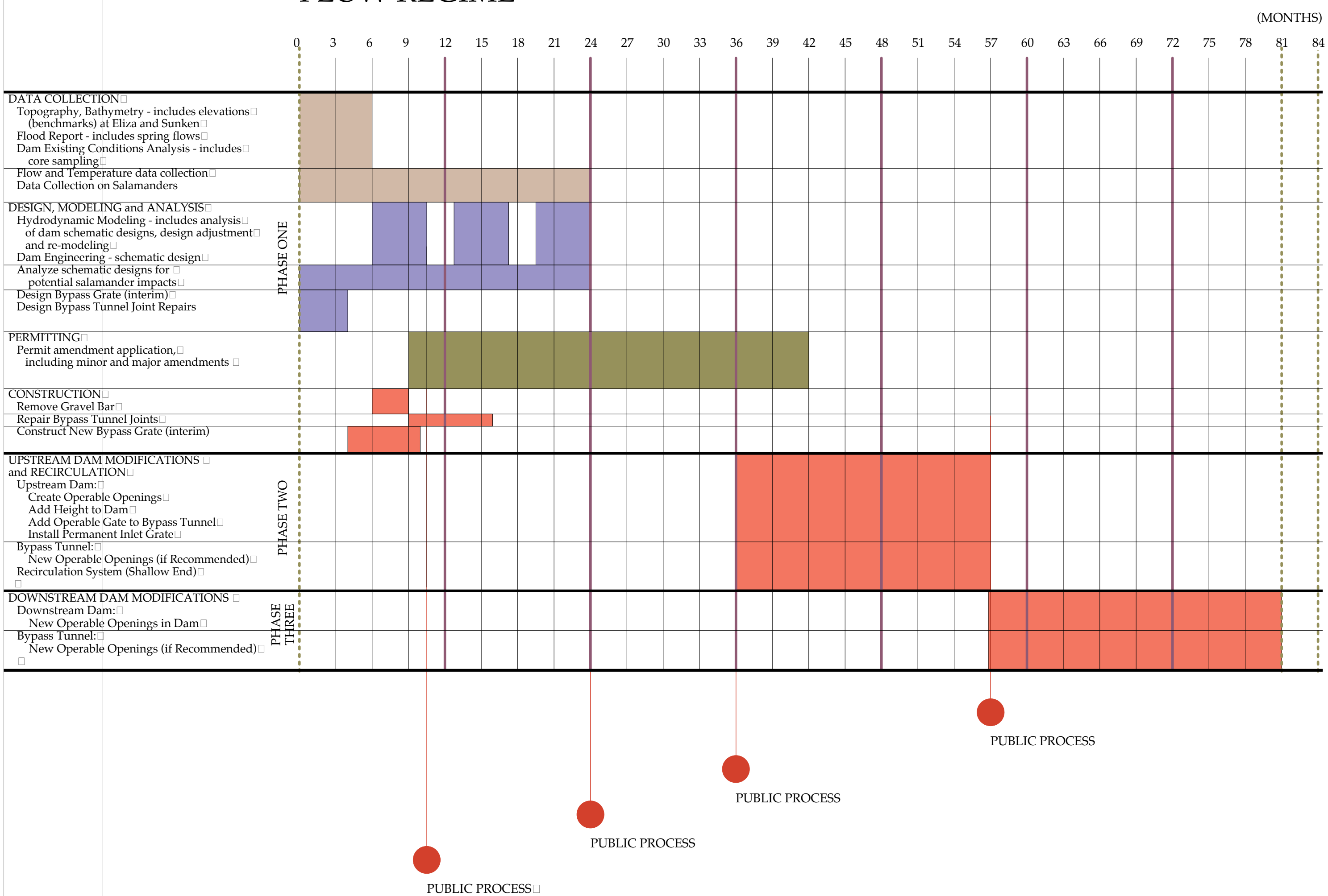
Flow Regime Improvements	*****
Renovate Eliza Spring	*779,569*
*Renovate Sunken Garden (part 2)*****	*613,431*
Subtotal	*1,393,000*
Contingency (25%)	*348,250*
TOTAL	*$1,741,250*

These estimated costs include construction costs, professional fees, administrative and soft costs.

**** Because the scope of this item cannot be determined at this time, it is not possible to offer an estimated cost.*

*****This estimated cost does not include a "new, more attractive, more transparent" bridge. It is included in Further Downstream Improvements.*

FLOW REGIME


(MONTHS)
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84
DATA COLLECTION
Topography, Bathymetry - includes elevations
(benchmarks) at Eliza and Sunken
Flood Report - includes spring flows
Dam Existing Conditions Analysis - includes
core sampling
Flow and Temperature data collection
Data Collection on Salamanders
DESIGN, MODELING and ANALYSIS
Hydrodynamic Modeling - includes analysis
of dam schematic designs, design adjustment
and re-modeling
Dam Engineering - schematic design
Analyze schematic designs for
potential salamander impacts
Design Bypass Grate (interim)
Design Bypass Tunnel Joint Repairs
PERMITTING
Permit amendment application,
including minor and major amendments
CONSTRUCTION
Remove Gravel Bar
Repair Bypass Tunnel Joints
Construct New Bypass Grate (interim)
UPSTREAM DAM MODIFICATIONS
and RECIRCULATION
Upstream Dam:
Create Operable Openings
Add Height to Dam
Add Operable Gate to Bypass Tunnel
Install Permanent Inlet Grate
Bypass Tunnel:
New Operable Openings (if Recommended)
Recirculation System (Shallow End)
DOWNSTREAM DAM MODIFICATIONS
Downstream Dam:
New Operable Openings in Dam
Bypass Tunnel:
New Operable Openings (if Recommended)
PHASE ONE
PHASE TWO
PHASE THREE
PUBLIC PROCESS
PUBLIC PROCESS
PUBLIC PROCESS
PUBLIC PROCESS