Appendix J

The table that follows includes descriptions of many of the techniques that could be used to restore Doan Brook. The restoration measures described match those discussed in Chapter 8. More detailed descriptions are given here to better define many of the techniques. Although the list of techniques is as complete as possible, the reader should keep in mind that other approaches to watershed restoration will arise as a detailed watershed management plan for the brook takes shape, as will new information about various measures that have already been discussed. This table and those in Chapter 8 should be considered only as starting points for an in-depth evaluation of measures included in the Doan Brook watershed management plan.

Table J-1	Description of Watershed Restoration Measures
Measure	**Discussion**
Large Projects	
***[1]Heights/ Hilltop Interceptor**	The HHI is a network of deep, large diameter sanitary sewers that is designed to collect sanitary sewage from a large part of Cleveland's eastern suburbs and divert the sewage directly to the Easterly Wastewater Treatment Center. The HHI (now under construction) will divert sanitary flow from much of the Doan Brook upper watershed and prevent it from flowing into the combined sewer system in the lower watershed. When completed, the HHI will reduce the volume of CSOs to Doan Brook to about 50% of its current level. The HHI will be partially in service in the Doan Brook watershed in 2001 and will be completed during 2005. Although the volume of CSOs will still be large after the HHI is complete (see Chapters 5 and 6), the HHI or a similar diversion is absolutely necessary if water quality in the brook is to be significantly improved.
High Flow CSO Storage	High flow CSO storage is one of the alternatives for meeting Ohio EPA CSO regulations that has been considered by NEORSD. As currently envisioned, the alternative would consist of some combination of the following: 1) a large diameter storage and diversion tunnel running along the brook between Gordon Park and Ambler Park (this is the alternative that is currently favored by NEORSD); or 2) large underground storage tanks at six locations in the lower watershed. Because there is a legal requirement that CSOs be reduced to the extent feasible, and because none of the smaller projects under consideration would accomplish this, some remedy that includes storage or high flow CSO treatment can be expected to be part of NEORSD's work in the watershed. The capacity of a high flow CSO storage system would be designed to control CSOs, not to reduce floods. As a result, the storage systems would probably be designed with enough capacity to contain CSOs from a storm that would occur every 3 to 4 months. This system would not provide enough capacity to have a major impact on flooding problems in the lower watershed.
High Flow CSO Treatment	High flow CSO treatment is among the alternatives NEORSD is considering for meeting Ohio EPA CSO regulations. A high flow CSO treatment system would intercept and treat CSO flows before discharging them to the brook. A preliminary alternative considered by NEORSD would involve small treatment facilities in six different locations in the lower watershed. NEORSD currently favors storage (and subsequent treatment at existing NEORSD treatment plants) rather than the installation of dispersed high flow treatment plants.
***Optimize the Existing Sewer System**	The performance of the existing sewer system can be optimized to maximize the use of existing storage volume and minimize CSOs.Optimization will be part of any NEORSD effort to reduce CSOs.

[1] *Projects that are currently in progress are marked with an asterisk.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Large Projects, continued	
Redirect Giddings Brook	Because much of the flooding on Doan Brook can be attributed to the diversion of Giddings Brook into Doan Brook, it is reasonable to consider the possibility of remedying Doan Book flooding by redirecting Giddings Brook flow back into the Giddings Brook watershed. However, given that the Giddings Brook watershed is also a heavily urbanized area with flow constrained almost entirely to a storm sewer system, it is extremely unlikely that such a rediversion would be possible without causing major problems in the old Giddings Brook watershed. It is even more unlikely that a rediversion would be cost effective.
Large New Stormwater Detention	Build additional large surface lakes or detention basins (like the MLK basin). Basins would be most effective at the western edge of the Escarpment or the eastern edge of the Lake Plain and should intercept flow that now goes to the Cedar Glen sewer or the Giddings Brook culvert. The watersheds of both of these culverts are dense urban areas, and it would be very difficult or impossible to find an appropriate location for additional large stormwater detention facilities.
Parallel Stormwater Culvert	Build a large culvert that would parallel the brook (most likely in the lower watershed) to divert non-CSO stormwater from the brook and carry it directly to Lake Erie. Because the volume of stormwater for even relatively small floods (one- to two-year frequency) is very large, it is unlikely that an effective stormwater diversion culvert could be built economically. Engineering issues associated with building such a culvert in the lower watershed would also be significant. Note that a parallel stormwater culvert is not the same as a high flow CSO storage tunnel (see above). A high flow CSO storage tunnel would be designed with sufficient capacity to control CSOs from a storm that could be expected to occur every three to four months. While a large tunnel (perhaps 20 feet in diameter) would be required for this, an additional large tunnel would be required for effective stormwater diversion.
Daylight Brook in University Circle	Recreate a stream channel near the former Doan Brook alignment for some or all of the reach of the stream that is now carried in the University Circle culvert. The channel could be used in conjunction with the existing culvert to carry the full flow of the brook in relatively large floods (up to at least ten-year) without flooding the Circle. Case Western Reserve University and others have recently expressed interest in a restored Doan Brook in University Circle. Daylighting the brook would be difficult and expensive (although not impossible) in this heavily urban area.
Daylight Brook in Gordon Park	Excavate a channel in the dredge spoil material in the Corps of Engineers Site 14 dredge spoil area at the mouth of the brook. Reopening the brook to Lake Erie could be expected to have a significant positive impact on the habitat in the brook; however, the cost of doing so would be extremely high, and the technical challenges involved in building any kind of natural stream channel in the dredge spoil would be significant. The 2000 Holden Parks Trust master plan includes a park on the dredge spoil area, but does not consider daylighting Doan Brook through the area.
Enlarge University Circle Culvert	The University Circle culvert is actually a series of culverts with different capacities and different cross sections that were connected over time. This measure would involve enlarging the culvert, particularly in its most constricted sections, so that it could carry the flow from larger floods. Under current conditions, it is unlikely that it would be feasible to enlarge the culvert enough so that it could convey floods larger than the ten-year flood (and perhaps not that large). This measure would need to be combined with others that reduce flow into the culvert in order to have a significant impact on University Circle flooding. An approach to enlarging the University Circle culvert was included in the 1964 Stanley Engineering study of Doan Brook flooding. Enlarging the University Circle culvert would not decrease flooding downstream from University Circle and might make downstream flooding more severe.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Large Projects, continued	
Keep University Circle Culvert Clear of Debris	The University Circle culvert is prone to gradual clogging as debris builds up in the culvert. It is not unusual for debris to fill half of the culvert. This measure involves instituting a program of regular maintenance to keep the culvert relatively free of debris. The concept of keeping the culvert clear is not new – it was recommended by Stanley Engineering in 1964. However, no regular cleaning program has ever been followed.
Enlarge Cedar Glen Sewer	Enlarge the storm sewer that carries flow down the Escarpment beneath Cedar Road and into the University Circle culvert. At present, the sewer is too small to carry flows from a five-year flood, so that water flows in the street down Cedar Hill during larger rains. Enlarging this sewer would be physically difficult, and, by itself, it would not have much impact on flooding except on Cedar Road.
Enlarge Rockefeller Park Channels	Enlarge Rockefeller Park channels so that they could convey larger floods without overflowing into the adjacent road. This measure is practical through most of Rockefeller Park, although limited space may make it difficult in some places. Channel enlargement alone, without accompanying culvert enlargement (see below), would not alleviate all flooding, since much of the flooding in Rockefeller Park results from water that is backed up by constrictions at the culverts that carry water under the historic bridges. Channel enlargement could be done in conjunction with the restoration of a more natural channel shape that would improve habitat. Enlarging the channels, even without channel restoration, would have some ecological benefit, since it would reduce the frequency of channel scouring by high flows.
Enlarge Rockefeller Park Culverts	Enlarge the culverts that carry the brook under the Rockefeller Park bridges. Enlarging the channel at the road crossings would be somewhat expensive in all cases. In addition, several of the bridges are designated as historic landmarks, so that modifications needed to enlarge some culverts could conflict with historic preservation interests. As is mentioned above, the culverts in Rockefeller Park are the greatest channel constrictions in many places, and they create much of the street flooding. Some modification to some of the culverts will almost undoubtedly be needed to alleviate flooding in this area.
Small Projects	
Revise City Codes to Require BMPs	Revise city codes to require that new construction and redevelopment incorporate stormwater "best management practices" (BMPs). Revisions might, for example, require that stormwater detention be included in new parking lot design, that road reconstruction incorporate grassed swales adjacent to the road where possible, or that new home construction incorporate some on-site stormwater detention. Although code revision may be politically difficult, it is essential to the sustained restoration of Doan Brook.
Redesign MLK Detention Basin Outlet	Redesign the outlet of the existing detention basin at MLK to more effectively control flows from the five- to ten-year storm. Preliminary analysis performed as part of the ongoing NEORSD study indicates that the basin outlet could be redesigned to somewhat reduce the area flooded during large floods (25- to 50-year), but that it would be difficult to redesign the basin to control smaller floods without causing the dam to overtop during the 50-year flood. Modification of the basin outlet would be relatively inexpensive.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Small Projects, continued	
Stormwater Retrofits	Stormwater retrofits are generally small stormwater management facilities that are added to a developed watershed. Examples of stormwater retrofits are: a small detention pond or wetland at a tributary culvert outlet; a sand filter that catches, temporarily detains, and filters runoff from a parking lot; a grassed roadside swale that captures and detains runoff, allowing some to infiltrate. Stormwater retrofits can be designed to improve water quality (by allowing sediment to settle, filtering contamination, or providing biological treatment of contamination by wetland vegetation), to decrease flooding, or, most often, to combine flood reduction with water quality improvement. They differ from measures described under "Large Projects" primarily in scale. Each large project is intended to address the problems of a substantial part of the watershed. By contrast, a single stormwater retrofit is generally intended to improve water quality or decrease peak outflow from a small part of the total watershed. Benefits to the watershed as a whole result from the cumulative impact of a number of stormwater retrofits strategically located throughout. A study of possible stormwater retrofit locations has been conducted by the Center for Watershed Protection as part of NEORSD's Doan Brook watershed study.
Stream Channel Restoration	Restore existing rigid sections of Doan Brook to more natural channel configurations. In general, a "natural" channel is winding, includes deeper pools and shallower riffles, has a pilot channel for low flows, a "bank full" channel that fills once every year or two, and an adjacent flood plain into which the stream overflows during floods. Restoration of the Doan Brook channel to a more natural shape is feasible to varying degrees along different reaches of the channelized stream, depending upon the space available. It could be undertaken one stretch of the brook at a time.
* **Channel Stabilization**	Stabilize eroding sections of the stream channel and banks. The preferred means of stabilization is to use natural and living materials such as stone, tree roots, and live plantings. Channel stabilization alone, without stream channel restoration, does not address the underlying tendency of the stream to create a channel that matches current flow conditions. As a result, the stream will have a continuing tendency to erode its banks and channel; however, channel stabilization is sometimes necessary to protect roads and bridges. In addition, it reduces the amount of sediment carried by the stream at least temporarily. Holden Parks Trust has installed natural channel stabilization measures and done some channel restoration along two stretches of the lower brook (just downstream from the University Circle culvert outlet and along the side of the Rockefeller Park Lagoon) as part of a pilot project.
* **Stormwater Outfall Monitoring**	Institute a regular monitoring program to verify that stormwater outfalls are not contaminated by sanitary sewage, followed by repairs to problems detected. NEORSD has a monitoring program in place.
* **Sanitary Sewer Maintenance**	Institute a regular sanitary sewer maintenance program to detect and repair cross connections and defects in the sanitary sewers that might lead to sewage discharge to surface water. Sanitary sewer maintenance is now undertaken by the cities and by NEORSD.
* **Reinforce Dams Against Failure**	Take steps to insure that the Shaker Lake dams will not fail during large storms. The Shaker Lakes play a critical role in controlling floods on Doan Brook and in the parks of the upper watershed. Their maintenance is very important.
* **Lake Dredging**	Institute a regular program of dredging for the Shaker Lakes. The lakes accumulate sediment that is washed into them and additional material deposited from the decay of organic matter. Over time, they become shallow and warm and are unable to support a healthy and diverse aquatic ecosystem. Although dredging does not address the sources of contamination to the lakes, it does foster a healthier lake ecosystem. It may also remove accumulated nutrients (primarily phosphorus) that have been deposited in the sediments. These nutrients may be recycled through the lake and add to eutrophication. The lakes have been dredged at irregular intervals; however, high costs have generally led to incomplete and irregular dredging.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Small Projects, continued	
* **Lake Aeration**	Install "bubblers" or artificial means of inducing lake circulation at several locations in each of the Shaker Lakes to bubble air through the water column. Aeration would help prevent dissolved oxygen levels in the lakes from falling to the extremely low levels that sometimes occur now, would increase fish and other organism survival, and would reduce the formation of noxious anoxic bacteria. However, aeration alone would not decrease plant growth, and it is unlikely that it would make much real impact on the health of the lakes unless it was combined with other measures. Aerators have been installed in Green Lake.
Aquatic Plant Management in Lakes	Take active measures to remove algae and aquatic plants from the Doan Brook lakes. Possible approaches include use of algacides or other chemicals, plant harvesting, and skimmers that prevent algae and plants from passing out of the lakes. Algacides and other chemical treatments are undesirable because of side effects. Other measures might improve the lakes aesthetically or improve downstream water quality and might remove moderate amounts of phosphorus from the aquatic ecosystem.
Lake or Stream Biofiltration	Install biofilter units in the stream or in the lakes to remove excess nutrients from the water. A pilot project at the outlet from Green Lake in 1999 demonstrated that biofilters effectively remove nutrients from the water. However, the overall effectiveness of biofilters in a natural stream system has not been demonstrated. Although biofiltration may have a significant role to play in restoring health to Doan Brook, the costs and effectiveness of the technology are uncertain.
Encourage Native Species and Discourage Invasive Exotics	Identify existing native and exotic vegetation in the natural areas of the watershed. Protect and encourage native vegetation while discouraging invasive exotic species. Insure that new plantings are of native species where possible and that no new invasive exotic species are introduced.
Species Reintroduction	Over time, a number of plant and animal species that once lived along Doan Brook have been eliminated from the habitat. Fish that once migrated from Lake Erie can no longer pass the culverts and dams; macroinvertebrate populations may have been eliminated by periods of particularly bad weather or high pollution levels; frogs and salamanders may have been killed by poor water quality and lack of breeding habitat; native plants were cleared by the Shakers and by later developers and must compete with exotic vegetation. If the water quality and habitat in the brook are improved, it may be possible to reintroduce some of these native species. Researchers from John Carroll University reintroduced three species of minnow to the brook between Horseshoe Lake and the Nature Center in 1999. Initial results indicated that these relatively hardy fish may once again thrive in the brook. Some species of plants or animals may reappear as the habitat improves, even without active reintroduction. Species reintroduction may enhance the biotic community of the brook, but sensitive new species will not thrive unless the brook habitat and water quality can support them.
Alternative Road Deicing	Use road deicers that are less toxic to aquatic plants and animals than sodium chloride and/or use more restraint when applying deicer.
Improve Golf Course Maintenance	Use less fertilizer, pesticide, and herbicide on golf courses, use low phosphorus fertilizer (as Shaker Heights Country Club already does), incorporate riparian buffer zones adjacent to the stream, restore the stream channel on the golf courses to increase habitat and reduce erosion, and incorporate stormwater retrofits in the golf course design. The golf courses in the Doan Brook watershed are private property, and owners and members must see the benefits to changes in golf course management before they can be implemented. However, there are several national programs that encourage golf courses to adopt environmentally positive practices. Canterbury and Shaker Heights golf courses own a large part of the land immediately adjacent to the south fork of Doan Brook, and the way that the courses manage their land has a major impact on the stream.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Small Projects, continued	
Discourage Nuisance Waterfowl	Large numbers of waterfowl, particularly Canada geese, are probably significant contributors to bacterial contamination in Doan Brook and the Shaker Lakes. Geese can be discouraged by limiting lawn areas adjacent to the lakes and allowing taller vegetation to grow up – that is, by promoting proper riparian buffer zones. Artificial means such as "scare goose" balloons can also be used, but they are generally only effective for a short time.
Protect Riparian Corridor	Protect the existing riparian corridor from development and inappropriate vegetation clearing.
Increase Riparian Vegetation	Increase the vegetative buffer adjacent to the brook by reducing lawn areas and encouraging the growth of native vegetation. This approach could be used in manicured parks, on golf courses, and by homeowners with property adjacent to the stream. Encouraging homeowners to plant buffer zones could be particularly useful in the upper reaches of all forks of the stream, since lawns frequently extend to the water's edge in these areas.
* **Street Litter and Debris Cleanup**	Increase cleanup of litter and debris (particularly from lawn care) in the streets. Approaches could include street sweeping, voluntary "adopt a block" programs, and citizen education.
Catch Basin Inspection and Cleaning	A regular program of inspection and cleaning of storm sewer catch basins to remove grit, oil, organic matter, and other contamination before it is carried to the brook.
Erosion Control During Construction	Require that sediment erosion from building sites be controlled.
Flow Augmentation	Increase dry weather flow by artificially introducing additional water to the stream. The most likely source of flow augmentation for Doan Brook would be the direct release of untreated Lake Erie water from the Baldwin Filtration Plant to the brook in Ambler Park.
Citizen Action	
Downspout Disconnects	Disconnect downspouts from the storm drain and divert flow from rooftops onto lawns where it can infiltrate, or at least be stored to some extent, rather than being carried directly to the storm sewers. Although downspout disconnects work well in many places, the clayey tills of the upper Doan Brook watershed make this measure of limited value there. Water will run off almost as fast from a lawn as it did from the rooftop. Because of the heavy clay soil and the associated risk of basement flooding, downspout disconnects should be evaluated with care to see whether they can be accomplished without flooding basements and to see whether they will provide a worthwhile benefit.
Rain Barrel Use	Reroute downspouts so that they flow into rain barrels. Overflow from the barrels can either be routed to the surrounding lawn (effectively a downspout disconnect) or to the storm sewers. Rain barrels will quickly be filled during really heavy rain[2], so that rain barrel storage will have an impact primarily during moderate rains.

2 A 0.1 inch rain will fill a 50-gallon rain barrel that collects rainfall from an 1800 square foot two story home.

Table J-1, continued	Description of Watershed Restoration Measures
Measure	**Discussions**
Citizen Action, continued	
Alternative Landscaping	Encourage individual homeowners to reduce the amount of turf in their yards, increase the amount of natural ground cover and bushes, and plant buffer zones to slow runoff. This could significantly increase infiltration and rainwater storage in each yard. It could also reduce the use of lawn fertilizers, herbicides, and pesticides.
* **Proper Auto Waste Handling**	Encourage proper disposal of automotive waste oil, anti-freeze and other fluids by regulation and public education and by providing convenient means of proper disposal. Existing programs should be reviewed and improved as appropriate.
Proper Car Wash Practices	Encourage residents to wash cars at commercial car washes that drain soapy runoff to the sanitary sewer rather than to the storm drain or, if this is not possible, to wash cars on lawns rather than in driveways and streets. Soap used for washing cars can be a significant source of phosphorus, and grit washed from cars can add sediment and oil to the brook. Use of low-phosphorus soaps for washing cars is also helpful.
* **Household Hazardous Waste Disposal**	Encourage residents to properly dispose of household hazardous waste by regulation and public education and by providing easy proper disposal. Existing programs should be reviewed and revised as needed.
* **Cleaning Pet Waste**	Require residents to pick up pet waste and dispose of it in the sanitary sewer system (not in the storm sewer!) or with household garbage. Pet (mostly dog) waste is probably the most significant single source of bacteria contamination in the watershed after CSOs. Appropriate measures include encouraging proper disposal by regulation and public education. Existing regulations should be reviewed, revised, and enforced as appropriate.
Reduce Lawn Fertilizer, Pesticides and Herbicides	Encourage residents to reduce or eliminate the use of fertilizers, pesticides and herbicides on lawns. Encourage use of low phosphorus fertilizer when fertilizer is used. Appropriate measures include public education and education of lawn care providers.
* **Proper Yard Waste Disposal**	Encourage residents to dispose of yard waste in proper compost piles or in city yard waste pickup, not in gutters, drainage ditches or streams. Appropriate measures include regulation, public education, and city yard waste collection. Existing programs should be reviewed and revised as appropriate.