VI - Ecological Restoration and Site Reclamation Plan

Overview

Restoring the native plant communities and reclamation of the quarries is integral to the overall master plan for the park. This section provides an overview of how that will be achieved and discussion of related issues. The section is divided into two segments:

- Ecological restoration
- Site reclamation

Ecological Restoration

The restoration plan puts emphasis on restoring the native plant communities within the park to a "sustainable" level. In this context, sustainable refers to a level of restoration that can be indefinitely propagated and maintained by staff and volunteers. Ideally, this level will approach a historic landscape that features native plant communities. That is a distinct possibility in this case given the likelihood of extensive involvement of volunteer groups, schools, and colleges in the restoration program. To the credit of the county staff, much of this volunteer network is already taking shape and ready to become active in restoration programs.

The following outlines the approach to ecological restoration that will lead to a sustainable landscape within the park.

Vegetation Dynamics

Vegetation within the park is closely related to several environmental gradients, including:

- Moisture gradients that correspond to topography -- the relative relief above wet quarry mines and lowland depressions.
- Time -- as a factor affecting the rates of vegetation invasion following historic mining and other land uses.
- Availability of propagules that continue to invade the park site since mining and other land uses ended.

These gradients have had the most influence on the patterns and characteristics of the vegetation within the park.

The third gradient listed, propagule availability and their dissemination efficiency has been a major factor impacting vegetative diversity. For example, seeds that are bird and wind disseminated were the first to reach the more central areas of the property in mined and farmed areas. Finding cottonwood and aspen suggests the presence of nearby seed sources and that wind dissemination into this environment was very successful and efficient. Animal (especially bird) disseminated fruits and seeds followed the wind disseminated species, based on tree and shrub age data collected on the site.

Evaluation suggests that the cottonwoods and aspen in upland sites will give way to other later successional trees and shrubs as time proceeds. The burr and hills oak encroaching on some of the semi-open sites will likely become dominants with time.

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Vegetation within the park also provides an interesting example of post disturbance succession, which is valuable from the perspective of education and testing of restoration practices. This site is unique in that few other examples of granite quarry sites of this size exist or have been studied. The restoration of other types of mine sites for wildlife and vegetation has been well established in the Midwest and elsewhere. Applying that knowledge to this setting will prove to be interesting and educational.

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Oak Savanna Importance and Condition

Field surveys have allowed for an understanding of the oak systems on the site and to draw comparisons with region-wide studies that began in 1985. These studies have included over 150 oak savanna sites and restoration treatments in six states.

The oak woodlands found on the site are very similar to the various barrens and sand savannas found in Wisconsin, Illinois, Upper Michigan, and Indiana. This is based on species composition and other descriptions, including the ecological changes that have occurred. Recent research on North America's oak barrens and savannas has suggested they have changed significantly since settlement by Indo-Europeans. Observed changes in oak woodlands within the park are essentially the same as the changes occurring across North America.

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Studies have shown that restoration of barrens and savannas to enhance biological diversity is very practical and achievable. Restoration of this site can be undertaken at any time since its degradation is now understood and the potential for restoration can be assessed. The resulting changes will provide significantly enhanced aesthetics and opportunities for education and nature appreciation. However, restoration is best undertaken only after park users have been sensitized to the changes that have occurred and to the restoration process.

Resource Management and Restoration Framework

Vegetative management and restoration plans require a carefully thought-out approach that will lead to a sustainable landscape. The following provides an overview and framework for developing a resource management and restoration plan.

Prescribed Burning as a Management Tool: Wildfire and fires started by indigenous people and natural causes have played an important role in the evolution and maintenance of many biological systems throughout North America. It is now being realized just how essential the role of fire is in maintaining grasslands, wetlands, savannas, barrens, and numerous forest types. It is also now realized that fire suppression can result in gross changes in the aspect, appearance, and ecological functions of natural systems. Fire suppression is often followed by a decline in the richness and diversity of native plants and animal species, increased litter, shading, phytotoxin build-up in substrates, decreased availability of essential nutrients and increased homogeneity in habitat structure and spatial heterogeneity. Reduced nutrient cycling and increasing domination by few species also can result. In some ecosystems, shifts in wildlife and increases in shade tolerant and less flammable plant species accompany fire suppression.

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Barrens and savanna ecosystems have a global distribution in temperate, subtropical, and tropical climes. Most are adjacent to grasslands and forested ecosystems. Sand barrens and savannas are generally in glacial outwash plains. The proximity of barrens and savanna to grasslands with frequent recurring fires suggests an important historic role for fire in maintenance of barrens and savannas.

Barrens and oak woodlands originally were contiguous communities influenced on a landscape level by widespread processes such as fire. Prescribed burning has been the primary prairie management tool, but only recently have efforts been made to use fire for the maintenance and restoration of barrens and savannas. Sand barrens are the most extensive remaining savanna systems in North America. Savanna on silt loam soils began to disappear with settlement and subsequent fire suppression. Only a few silt loam savanna remnants of even moderate quality now remain.

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The presettlement flora and fauna of sand barren, savanna, and oak woodland communities have been changed less by agriculture than savannas on better soils. Reduced vegetation production in sandy soils results in these systems being less vulnerable to fire suppression. However, livestock grazing may have greatly affected the diversity and structure of barrens and savannas.

Restoration Potential: The proposed Granite quarry Park site has high recuperative potential under a program of ecological restoration. Savannas, wetlands, old fields, and outcrops plant communities would all benefit from various restoration strategies. The use of prescribed burning is a key aspect of virtually all of these strategies.

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Because of the existing diversity of plant life present, and remnants of native plant communities in particular, the site is expected to respond very quickly to restoration treatments. It should be expected that all natural communities will need to be managed to achieve a consistent, sustainable landscape into the future. Figure 6.1 provides a framework for ecological management and restoration.

Figure 6.1 - Ecological management and restoration.

Issue	Management/Restoration Practices
Lack of oak regeneration and virtual dominance by older age classes of black oaks is a major ecological concern. The dominant oaks are at or about to reach pathological maturity and will begin to degenerate rapidly. This is very problematic because older trees do not vegetatively regenerate.	Future canopy cohorts will depend entirely on acorn production and seedling establishment and survival. Management /Restoration Practices: 1) Prescribed burning on a regular (1-3 year) rotation. 2) Seeding with locally collected native plant seeds where native species do not respond to the above treatments. 3) Stimulation of oak regeneration and introduction of acorns and seeding oaks to soften geometric farm field edges.
A very high proportion of non-native grasses and other nonnative plants provides little opportunity for native ground cover species to establish or persist, or to flower and reproduce and thus many species have steadily declined. There is serious doubt that many species except those with long-lived soil propagules will continue to survive under these conditions.	Because of non-native grasses and other aggressive perennial plant species covering portions of the site, it is likely that establishing and spreading desirable native ground cover species will not occur without management. Management /Restoration Practices: 1) Prescribed burning on a regular (1-3 year) rotation. 2) Seeding with locally collected native plant seeds where native species do not respond to the above treatments. 3) Spray herbicide treatment to reduce existing persistent non-native grasses. 4) Inter-seeding of native prairie grasses and forbs in existing old farm fields conducted by no-till drilling or scattered by hand after prescribed burning. Tillage is not desirable as this could stimulate weed species seeds.
High shrub, sapling, and invasive tree intercept contributes to very dense shading in some locations, leaving few native species of ground cover plants to occur. Invasion of woody plants by inadvertent or intentional introduction will continue to occur in existing open areas. This will seriously threaten the few and small remaining open areas where the majority of the ground cover plant biological diversity remains. Recent introduced species such as European buckthorns represent a major threat to the continued functions of the remaining savanna remnants and contained rare plants.	Management /Restoration Practices: 1) Prescribed burning on a regular (1-3 year) rotation. 2) Spray herbicide treatment and manual reduction of undesirable introduced shrubs (i. e., European buckthorn). 3) Seeding with locally collected native plant seeds where native species do not respond to the above treatments.
A precipitous decline in breeding bird use is occurring with the decline in oak systems. Avian use declines with continued deterioration of the oak systems. Recent studies document the decline from over 28 native breeding bird species in quality oak systems to only 4 in serious degraded oak systems.	Occasionally increases in such species that are members of guilds, including timber drillers and ground brush foragers, will occur as oak canopy temporarily decreases with individual tree senescence and deterioration, but the long-term trend in avian richness is a drastic decline.
The excessive canopy closure tends to accelerate overland flow of water, resulting in poorer water quality in downstream areas (like the quarry pits and wetlands). Likewise, increased human use of the site will increase erosion and potential impacts to vegetation.	Management /Restoration Practices: 1) Integration of stable trail system and trail side vegetation to reduce erosion caused by increased human use. 2) Undertake practices already defined to reduce extent of canopy enclosure and foster vegetative diversity that prevents excessive overland flow of water.

Conclusions and General Recommendations: Field survey and research suggests the following conclusions:

- Relatively high quality natural area remnants exist within the park.
- Most of the park's vegetation has high recuperative potential with restorative management programs.

Figure 6.2 provides some additional recommendations for ecological restoration and management of the park.

Figure 6.2 - Recommendations for ecological restoration and management of the park.

Condition	General Recommendation
Restoration Feasibility Testing	Establish a series of restoration experiments to determine site specific restoration feasibility and fine tune various approaches used elsewhere. This includes, among other methods, prescribed burning, removal of invasive woody species, transplant of non-native smaller calliper trees, etc.
Environmental Education	Support a carefully developed environmental education program to educate residents and visitors about the unique and beautiful oak savanna and facilitate a greater understanding of the importance of restoration programs.
Staffing and Working Space	Commit county staff and provide adequate space for collecting and propagating desirable native species which are not regenerating in the park.
Ensuring Long-Term Water Quality	Carefully devise mechanisms for protection of water quality in the park by: a) entering into cooperative agreements with adjacent land owners to offer tributary area protection, and b) by very controlled use, planning, and water quality monitoring of pit lakes.

Site Reclamation

Site reclamation focuses on the rehabilitation of quarries and adjacent grout piles to ensure public safety. It also considers water management and quality issues.

In this context, site reclamation is concerned with protecting the public from unexpected and unpredictable happenings caused by past mining activities. An example of this would be granite debris falling off of a grout pile and landing on a designated trail. This section identifies this type of potential occurrence and identifies measures that can be used to remedy the situation. The section is organized into categories:

- Grout pile stability
- Quarry mine pit stability
- Hydrology and water quality

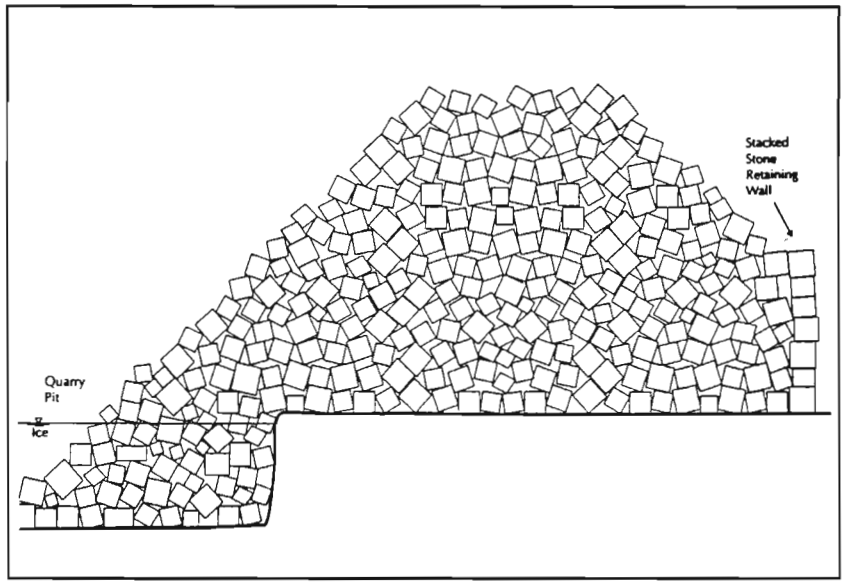
Grout Pile Stability

Fortunately, contemporary engineering practices have devised ways to deal with these types of occurrences.

In general, the grout piles adjacent to the quarries appear to have stabilized over the years since mining took place. Technically, however, they are subject to the dynamics of nature and therefore some shifting may occur. Although the amount of movement is usually minimal, some signs of this happening has been observed. In instances where instability is a concern to the safety of the user, preventative measures will be taken to ensure a safe park environment. Fortunately, contemporary engineering practices have devised ways to deal with these types of occurrences. The following provides an overview of grout pile stability and defines methods that can be used to ensure that they remain stable.

Background: The stockpiles are waste dimension rock from the abandoned quarries. Most of the dimension rock are between two to four feet square. Some of the rock was dumped and is sloped at the angle of repose as shown in Figure 6.3. Other rock was stacked on the lower portion of the stockpiles to act as retaining walls as also shown in Figure 6.3.

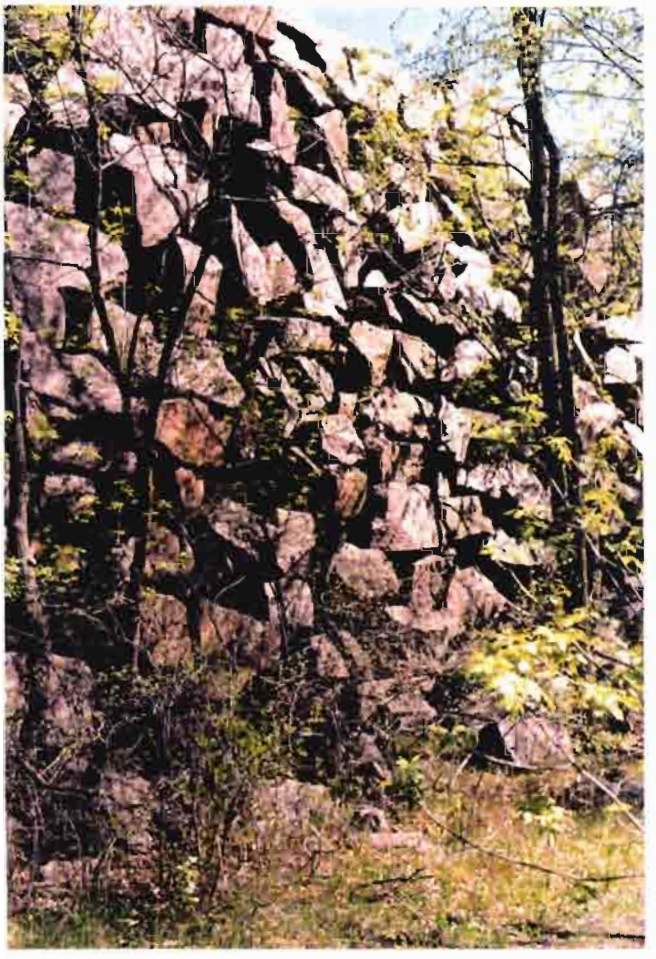
Figure 6.3 - Illustration of typical stockpile configuration.



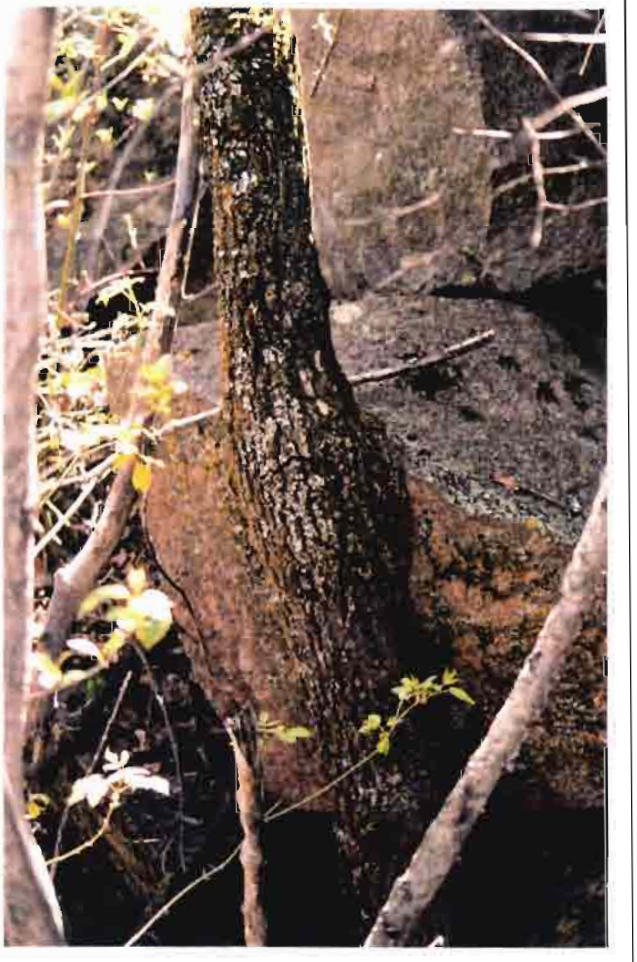
The stockpiles are generally between 30 and 60 feet high. To varying degrees, their stability is essential to the safety of the park users. Figure 6.4 illustrates some of the conditions that may be encountered. Figure 6.5 illustrates some of the failure mechanisms that can occur on these stockpiles.

Figure 6.4 - Photographs of potential failure mechanism.

Grout pile debris scattered along trails will have to be stabilized to ensure user safety.

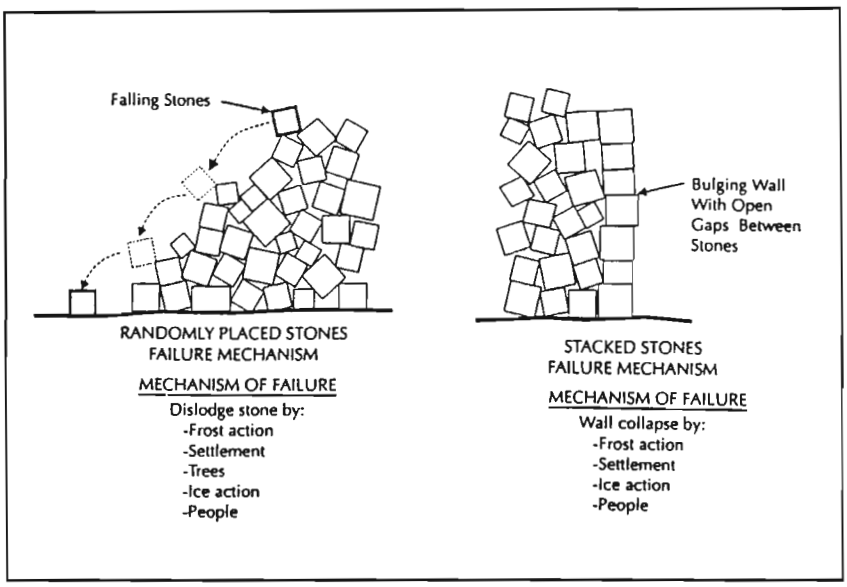


Bulging grout piles will require stabilization if adjacent to trails and facilities.



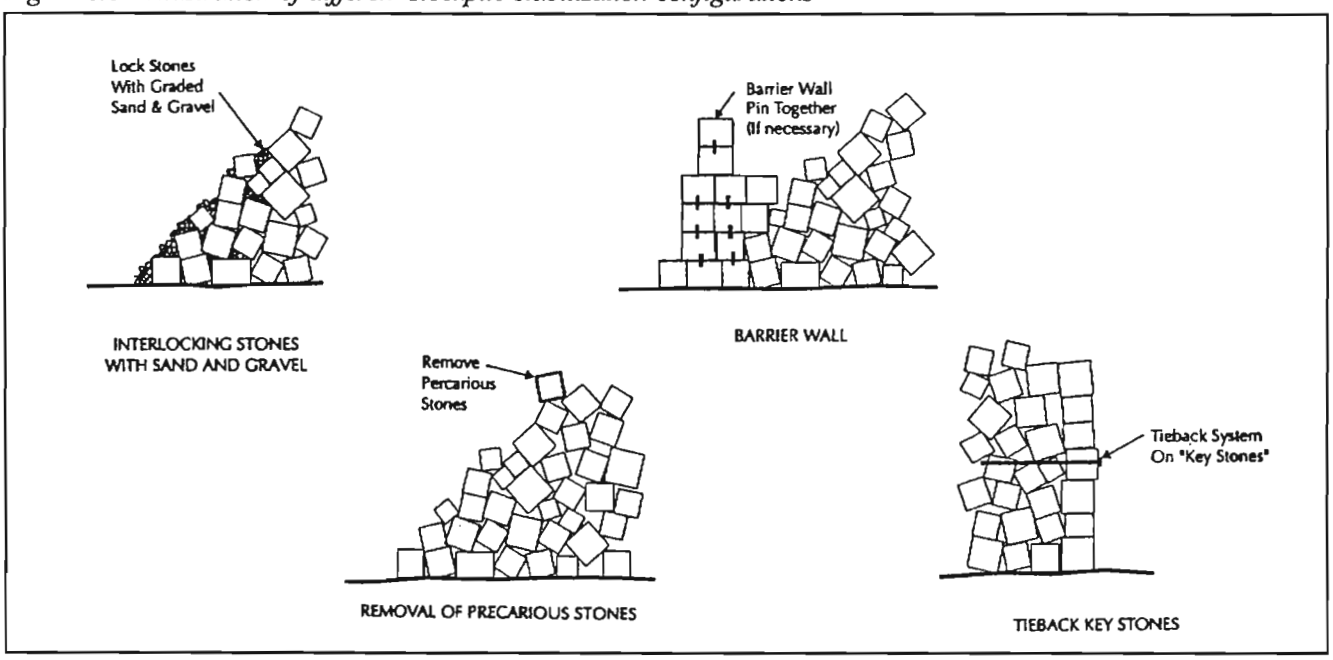
Conditions where trees and other items are supporting grout piles will have to be eliminated if adjacent to trails and facilities.

Figure 6.5 - Illustration of different failure mechanisms.



Stabilization Measures: There are a number of ways in which grout piles can be stabilized to ensure public safety. Some of the methods are shown in Figure 6.6. These methods have particular application when grout piles are placed on bedrock. Other methods may be required in instances where stockpiles are placed on glacial till rather than rock. In limited situations, trails and site amenities may have to be located to simply avoid a particular area of uncertainty.

Figure 6.6 - Illustration of different stockpile stabilization configurations



Quarry Mine Pit Stability

As with grout piles, the quarries appear to be stable. Although typically more stable than grout piles, they too are subject to the dynamics of nature, especially the effects of freeze-thaw cycles. Signs of this happening in some of the quarries is observable. In instances where instability is a concern to the safety of the user, preventative measures will again have to be taken to ensure a safe park environment. As with grout pile stability, contemporary engineering practices have devised ways to deal with these types of occurrences. The following provides an overview of quarry mine pit stability and identifies methods that can be used to ensure they remain stable.

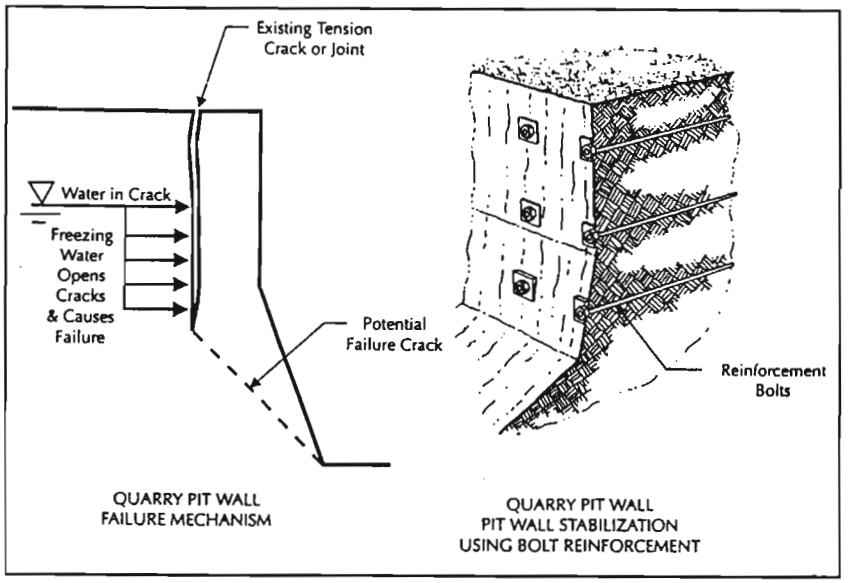
Background: The quarry pits are essentially vertical holes cut into the granite that have filled with water. Water is generally within several feet from the ground surface with the depths varying from quarry to quarry. The deepest quarry is 116 feet and the shallowest quarry is five feet. The average depth is about 45 feet. The quarries themselves cover a relatively small area totaling less than 10 acres. The largest quarry is over three acres and the smallest is less than 0.1 acre. The average area of all the quarries is about 0.5 acres.

In some instances, the walls of some quarries show evidence of normal deterioration. Figure 6.7 is a photograph of a quarry pit that exhibits this condition. Figure 6.8 is an illustration of how the pit quarry face can in some instances deteriorate and become unstable.

Figure 6.7 - Photograph of quarry pit wall.

Stabilization Measures: As with grout piles, there are a number of ways in which quarry walls can be stabilized. Figure 6.8 shows the mechanism for stabilizing the pit quarries in those areas that require stabilization.

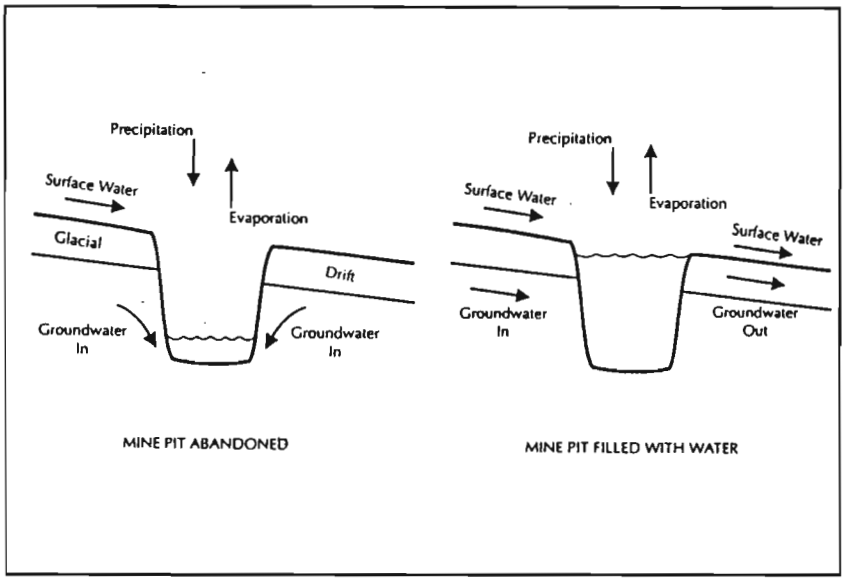
Figure 6.8 - Illustration of quarry wall stabilization.



Hydrology and Water Quality

The quarry receives water from precipitation and from other on and off-site sources through surface water runoff and groundwater. These sources have filled most of the quarries with water. Figure 6.9 illustrates the hydrology of the quarry pits and shows the sources of water flowing into them.

Figure 6.9 - Hydrology of quarry pits.



The dynamics of the site's hydrology has affected the master plan in a number of ways:

- The wetlands and quarries created between the interrelationship of hydrology with geology and other natural forces are integral aspects of the master plan.
- The locations of trails, rock climbing walls, swimming quarries, etc. are based, in part, on the effect of hydrologic forces.
- The stability of some of the grout piles are subject to water running beneath and through them.

Water quality is another important aspect of site hydrology. Today, the quality of the water remains very high, with limited impurities being found in initial tests. Maintaining this high level of water quality will become more of a challenge in the future for a couple of reasons:

- Increased human activities in the park may cause degradation to water quality through erosion, human waste, and trash.
- Development peripheral to the park may increase sediment runoff into the on-site wetlands and quarries.

Natural causes may also contribute to concerns about water quality. Limited circulation within the quarries (through wind action) coupled with poor surface area to depth ratios raises concerns related to stagnation and water quality degradation.

Site Reclamation Management Framework

For each of the site reclamation issues identified above, there are solutions that can remedy immediate concerns and minimize the potential for longer-term threats.

For each of the site reclamation issues identified above, there are solutions that can remedy immediate concerns and minimize the potential for longer-term threats. The key to managing these issues includes:

- Understanding their inherent dynamics.
- Monitor changes in those dynamics.
- Remedy threatening situations before they become serious concerns.

Figure 6.10 provides a framework for site reclamation. As the framework defines, site reclamation focuses on stabilizing the existing grout piles and quarries rather than eliminating them by reestablishing the original contours (which is a more typical restoration approach in the mining industry). This approach was selected because these landforms are considered key aspects of the park and part of its unique character. As such, public sediment strongly favored preserving the quarries and grout piles as a reflection of past cultural activities.

Figure 6.10. - Framework for site reclamation and hydrology/water quality management.

Reclamation Issue	Comment	Management Framework
Grout Pile and Quarry Mine Stability	In some instances, stabilizing the grout piles within the park may become necessary to ensuring a safe park environment. Once areas of concern are identified, engineering techniques can be employed to remedy unstable conditions and/or prevent further deterioration.	As the project moves forward into implementation phases, a detailed assessment of the grout piles and quarry walls will be required in areas affecting public safety. Appropriate measures should be taken to remedy any areas of concern. This work should be undertaken in conjunction with phases of site development.
Hydrology and Water Quality	One of the key issues in water management is the fluctuation of water in the quarry pits. Although the water within them seems stable in terms of filling, the water elevation will fluctuate in accordance with climatic cycles. The amount of fluctuation is dependent upon the hydrologic factors of precipitation, evaporation, runoff, and groundwater. Since the quarry pits are a central feature of the master plan, management of the water within them is essential. Given this, greater understanding of the hydrologic/hydrogeologic characteristics of the site is recommended.	A water management plan that quantifies the sources of water and the impact of this water on the quarries is a necessary part of developing the park. A detailed hydrologic/hydrogeologic study is recommended to establish the hydrology of the park and contributing watersheds so that proper drainage and quarry pit fluctuation can be determined. The study should include a monitoring program to measure water elevations within the quarry pits and pertinent climatic conditions so that water fluctuations can be predicted. A network of monitoring wells should be established to define the groundwater flow.The surface water drainage from adjacent contributing watersheds should be incorporated into the drainage plan of the quarry so that fluctuations in the quarry pit water can be estimated and managed.
Water Quality	The quarry pits are semi-isolated reservoirs that might become stagnant over time. The amount of stagnation is a function of the nutrients supplied to the water, the water circulation, and time. Circulation in the quarry pits is less than in normal lakes because winds are less able to mix the water due to their relatively great depth compared to surface area. A high depth to surface-area ratio tends to prevent vertical mixing during fall and spring when lakes normally become isothermal, top to bottom and may result in permanently anaerobic conditions in the lake's bottom waters – which under extreme conditions may lead to offensive odors . Vehicles found in the quarries should be investigated to determine if fuel, oil, and grease is present. The potential effect of these elements being found should be evaluated as part of the water study.	Understanding the limnological aspects of the quarry pit water is important in preserving or enhancing the water quality within them. A detailed water quality study should be performed to predict the water quality within the quarry pits. If the study determines that water quality enhancement is necessary, an appropriate technique such as a water circulation system or nutrient depletion method can be used to enhance the water quality. In addition, the water study should detail ways to prevent nutrient runoff from flowing into the quarry pits. This should include a review of the impact of runoff and groundwater recharge from the adjacent contributing watersheds.