# Mining Reclamation Newsletter

Wisconsin's Nonmetallic Mining Reclamation Program

## **SPECIAL ISSUE:** Considering Highwalls in Developing Reclamation Plans for Nonmetallic Mining Sites in Wisconsin

***April 2003***

Depending on their location, highwalls may pose various safety or pollution hazards and serve as attractive nuisances. Instead, quarry highwalls may be reclaimed to creative and productive post-mining land uses. The bottom photograph is courtesy of Bruce Brown of the Wisconsin Geologic and Natural History Survey.

## HIGHWALLS PART 1

### History & Context Tom Portle

The issue of highwalls has emerged as one of the most troubling to many involved with the preparation and review of reclamation plans under NR 135. It is hoped that a history of the rule development will foster a better understanding of the rule, why it is written as it is and how this bears upon program implementation.

***History***: To better understand this complex issue, it is important to look back at the historical context of NR 135 rulemaking. Early in the rulemaking process it was decided to make as clear a line between reclamation and zoning as possible. Also, there was a line drawn between operations and reclamation. This line often has a bearing on the highwall issue. The initial versions of the statute and thus the rule included a buffer zone or "setback" from a property line.

> "*Buffer areas necessary to assure appropriate final slopes after nonmetallic mining reclamation."*

The former statutory language given above emphasizes link between land-use and zoning decisions (made prior to mining or to a major expansion of the mine) and reclamation questions. It should be kept in mind that mine operation procedures are a consequence of both land-use and zoning decisions which, in turn, either set the stage for or limit the reclamation possibilities at the site. In practice, the reduction or elimination of a highwall is usually highly dependent on the mine's operation plans. For best results, the operation plan must be designed and conducted in a manner to support the highwall decision (either leave, reduce or eliminate highwalls). Usually reducing or eliminating highwalls means that it is necessary to leave a portion of the mineable resource in place. As such, it is an acknowledgment that to comply with land use requirements there are often trade-offs to be made. These "trade-offs" reflect the land use decisions.

To illustrate, if an existing quarry extracts right up to the property line, the opportunity to mitigate highwalls is limited to backfilling. Thus, a buffer zone or setback is a key component needed to address the mitigation or elimination of highwalls. However, the buffer zone or setback, as discussed above, is considered to be a zoning matter. That's why the Technical Advisory Committee (TAC) that advised the Department during rulemaking felt strongly that addressing buffer zones or setbacks in the reclamation standards was inappropriate since it would infringe on local zoning decisions not reclamation required by NR 135. As a result, the language addressing buffer zones or setbacks was eliminated from the revised statutes in ch. 295 and the corresponding NR 135 rule.

In the past, reclamation was too often limited to being a reaction to an existing mining situation. Now, land use and zoning decisions may be made prior to any mining operations. Once made, the land use decision must be supported by the reclamation plan

(by a well-conceived operation and reclamation plan) in order to leave the mine site in a productive and valuable condition.

All zoning decisions are based on current land use plans and are implemented by zoning regulations (also see Part 2, Question 2 below). In the future - as a result of the Smart Growth process - a larger portion of the state will be subject to land use regulations and there will be a clear connection between the land use plan and its implementation through zoning.

## HIGHWALLS PART 2

### FAQ's on Highwalls and Reclamation Phil Fauble

Recently the Department has received numerous inquiries regarding the appropriateness of leaving intact highwalls as part of a reclamation plan for a nonmetallic mine site. Most of these questions centered on safety concerns and methods for dealing with reclamation plans that propose leaving unaltered highwalls after mining has ceased. To address these concerns, we need to start with the answers to some basic questions:

**1. What is a highwall?**

Highwalls are not given a formal definition in either the Wisconsin codes or statutes. Various regulatory entities have definitions, but the most straightforward definition comes from the State of California (s. 3701, 1975 Surface Mining Reclamation Act), which defines highwalls as "*the unexcavated face of exposed overburden and ore in a surface mine*". This can be further defined as an exposed face that exceeds the angle of repose in unconsolidated sediments or a nearly vertical face in the case of consolidated rock.

**2. What standards have been established in NR 135 for highwall reclamation?**

Some basic reclamation standards are established under s. NR 135.10(1), Wis. Adm. Code: "*All areas affected by mining shall be graded in accordance with the approved reclamation plan to achieve a stable and safe condition consistent with the post mining land use. The reclamation plan may designate areas such as stable slopes and rock faces that do not require final grading.*"

Another general requirement that may affect the appropriateness of a highwall can be found under s. NR 135(19)(3)(a), Wis. Adm. Code: "*The proposed post-mining land use shall be consistent with local land use plans and local zoning at the time the plan is submitted, unless a change to the land use plan or zoning is proposed.*"

What this means is that an operator may propose leaving intact highwalls as part of a final reclamation plan, provided the proposed highwall is left in a stable and safe condition. The operator must also demonstrate that the presence of a

highwall is part of a post-mining land use compatible with existing zoning and land use plans. An outright prohibition of highwall conditions or prescriptive setback requirements from cliff edges can only be enacted through zoning or conditional use permits.

**3. How do you determine the stability and safety of a highwall?**

Wisconsin's administrative rules governing reclamation do not specify what constitutes a "stable" and "safe" highwall, nor do they provide a methodology for making such a determination. It is the responsibility of the operator to demonstrate to the regulatory authority (RA) that the proposed remaining highwalls will be left in a stable and safe condition. The operator does this by providing the RA with details and specifications of the highwall in the reclamation plan.

Having said that, there are some general rules that can help a RA or operator determine whether or not a highwall will be stable. Slopes consisting of unconsolidated materials such as sand, gravel, silts and highly fractured rock are only stable at slope angles equal to or less than the angle of repose for that particular material. For most unconsolidated materials, the angle of repose is between 30 and 35 percent (an approximately 3:1 slope) and slopes greater than this are inherently unstable. **Therefore, highwalls should not be considered for unconsolidated materials (see photograph below).** This is especially true of unconsolidated overburden to be left above the top of the highwall, where research has shown the majority of slope failures in highwalls occur.

Consolidated rock may be considered stable at angles up to 90 degrees depending on several factors such as the rock type, bedding planes, zones of weakness, degree of fracturing, and resistance to erosion. For example, at one site a massive Silurian dolomite might be considered a good candidate for a vertical highwall, while that same rock at another location may not be stable in a vertical condition due to extensive fracturing, alteration or dissolution.

There are geotechnical methods available to assess the stability of a rock face. ASTM describes many various methodologies for measuring rock strength and

deformability (i.e., through uniaxial-compressive testing), but these testing protocols often require specialized equipment and training and are beyond the capabilities of most operators. This sort of specific, specialized testing should be required only in instances where the potential for significant damage from a slope failure (i.e., there is a building proposed at the base of the highwall) is high.

**Figure 1.** Sequence of reclamation of an unstable highwall composed of unconsolidated material to a stable slope as part of the productive post-mining land use.

**4. Are there any MSHA standards concerning highwall safety?**

The Mine Safety and Health Administration (MSHA) does have a few general rules concerning highwall safety and lots of useful guidance.

However, while the MSHA rules are good starting points, it is important to note that their rules are intended to protect worker safety at active mine sites, not to specifically address safety concerns after closure.

The two rules that are applicable are as follows:

**30 CFR 56.3130** - *Mining methods shall be used that will maintain wall, bank and slope stability in places where persons work or travel in performing their assigned tasks.*

**30 CFR 56.3131** - *Pit or Quarry Wall Perimeter. In places where persons work or travel in performing their assigned tasks, loose or unconsolidated material shall be sloped to the angle of repose or stripped back for at least 10 feet from the top of the pit or quarry wall. Other conditions at or near the perimeter of the pit or quarry wall which create a fall-of-material hazard to persons shall be corrected.*

In addition to these rules, MSHA goes a bit further with some guidelines for implementing safety measures to achieve their goal of a safe highwall condition. Basically, MSHA defines an area 6 feet or less from the stable crest of a highwall as a "Fall Hazard Zone". To increase worker safety in this zone, MSHA outlines 3 different strategies, all of which should be utilized to some degree dependent on the individual circumstance. They **are visual warnings, physical barriers and slope modification.**

**Visual warnings**
Typically, visual warnings include signs and markers that warn workers and others that a highwall is near and extreme caution should be taken. These signs should be posted in advance of the 6-foot hazard zone setback from the cliff edge.

**Physical barriers**
Physical barriers can be used to prevent people from accessing the crest or base of the highwall. These may include berms, boulders, or various types of fencing.

**Slope Modification**
Finally, the highwall can be modified to increase safety from both falls from the crest and falling rock at the base. MSHA recommends minimizing or removing dangerous features such as overhangs and backbreak (large chunks of rock that have split from the rock face). They also recommend scaling the rock face (dragging a backhoe bucket or chains across the exposure) to remove loose material that may be prone to dislodging and falling. As required in the rules, they also recommend removing or gently sloping unconsolidated overburden within 10 feet of the cliff edge.

5. **Do any other regulatory authorities have highwall reclamation requirements?**

Mine reclamation requirements for highwalls vary considerably between different regulatory agencies. One thing that they all have in common is the requirement that any remaining highwalls be made as stable and safe as possible.

The Wisconsin Department of Transportation (DOT) has some general rules under sec. 205.3.6 of the Standard Specifications for Highway and Structure Construction for excavating rock. There are no detailed specifications beyond a general requirement that the backslopes of rock cuts be scaled to dislodge loose rock.

Many State agencies have their own reclamation standards. Some of the best and most complete examples are from Oregon and Washington States. In their "*Best Management Practices for Reclaiming Surface Mines in Washington and Oregon*" they suggest post-production blasting to break up linear features and placing a bench or berm at the top or base of the highwall to enhance public safety. They recommend placing a bench at the top of the highwall at least 10-foot high and 15-feet wide to discourage access and reduce injuries.

**6. How can highwall management measures be included within the reclamation plan?**

In accordance with ch. NR 135 requirements, it is the responsibility of the operator to demonstrate that the slopes proposed in the reclamation plan achieve a safe and stable condition. The stability of the rock face will be dictated by the competency of the rock and the appropriate safety measures will likely be dictated by the nature of the final use and the dimensions of the highwall.

If the RA reviews the reclamation plan and determines that the safety and stability issues associated with the proposed highwall have not been adequately addressed, they may, as provided in s. NR 135 .19(7), Wis. Adm. Code, either request additional information from the applicant, deny the plan, or attach appropriate conditions. Concerns about setbacks from neighboring property owners or structures should be addressed through zoning. However, if the regulatory authority has legitimate concerns about the proximity of a highwall to a structure or roadway, they may require additional information from the operator demonstrating the stability or safety of the highwall.

Remember that the final end use will dictate whether or not highwalls are appropriate for the site and the level of detail needed to establish a safe and stable condition. If the site is to be in close proximity to subdivisions or other population centers, safety and site access restrictions become a major concern. Smooth, clean rock faces may be desirable along roadways, but wildlife that utilizes rock faces prefers rough faces or benches. If a building is proposed at the base of a highwall cut, rock falls become a very real concern and a detailed slope stability analyses may be needed. If a highwall is being left for the purposes of geologic study, there should be some evidence that the rock cut has some scientific value (e.g., it's a type section, it's heavily used for university field trips, or is the focus of at least one or more scientific papers or reports).

**Figure 2.** A stable highwall alongside State Highway 14. Understanding the nature of the geologic material is essential to predicting its long-term stability (Photo courtesy of Bruce Brown).

## HIGHWALLS PART 3

### Factors That may be Considered When Thinking About Highwalls

**Tom Portle**

This part is intended to provide: 1) a conceptual framework for thinking about highwalls, 2) information not provided elsewhere in the article, and 3) two tables to assist the reader in finding pertinent information and finally a summary of this article.

When considering the matter of highwalls, whether as an operator preparing a reclamation plan or as a reviewer, there is a need to consider a number of factors or combinations of factors. These factors may be unique to any given case.

### Factors Required in A Complete Reclamation Plan

Any of the information requirements found in NR 135.19, may have a bearing on the evaluation of safety and stability and thus are important in complying with the reclamation standard NR 135.10 (1) requiring a safe and stable final slope consistent with the post-mining land use.

1) New mine versus existing mine or expansion at an existing mine.

2) Type of mining operation/material mined - is it a consolidated deposit (perhaps limestone quarry) operation versus unconsolidated deposit (sand and gravel pit) type operation?

3) Local setting including geology and socioeconomic environment.

**HARDROCK QUARRIES**

- Generally in northern part of state;
- Rock faces and slopes generally very stable;
- Contour or other modifications to slopes in existing quarries generally very difficult & expensive; and
- Low rock permeability & high water table pose opportunities for lake or pond as post-mining land use.

**LIMESTONE (DOLOSTONE QUARRIES)**

- In most cases where highwalls are present stability is good;
- Bluff quarries are generally dry and have a high working face;
- Deep flatland quarries will fill with water and can be opportunities for lake or pond as post-mining land use; and
- Contour or other modifications to slopes in existing quarries, after the fact, can be difficult & expensive but less so than hardrock quarries.

Excerpts from Bruce Brown's Presentation in Fond du Lac, Wisconsin, on March 18, 2003.

**Factors Dependent on Zoning**

Compatibility with local land uses patterns, regulatory (zoning) environment and population density.

- How well does the proposed highwall fit into the local physical environment?

- Is the terrain rugged? That is, are natural escarpments, and bluffs common in the area?

- Have you consider the degree that a safety hazard may exist considering local land use patterns and population density, etc.

**1) Realistically - What can be done?**

To begin with, it should be pointed out that **this discussion is not intended to imply that there is regulatory authority to require any particular approach**. First, zoning authority may or may not exist in a given jurisdiction. Issues of compatibility with the land use plan and zoning can only apply when zoning regulations exist. Secondly, only

the outcomes of safety and stability are addressed in the reclamation standards. Instead, the following discussion is a summary of the thought process and the mitigation options that are widely employed by the mining industry in the USA, Canada, Australia, Great Britain and indeed, worldwide.

There are a limited number of options in mitigating highwalls. Unfortunately, in the case of existing mines or in parts of the state where no local zoning exists the available options are further limited. Again, there are no explicit requirements in NR 135 to require any given approach to highwall reclamation. The following list is for the purpose of facilitating creative thinking on this matter, and promoting voluntary "win - win" approaches to addressing highwall concerns. This list is not intended to be all-inclusive:

a) For a new mine or a major expansion of an existing mine the mining plan may be designed to facilitate the reclamation plan and leave more gentle slopes and perhaps improve safety by leaving some resource in place. This often implies that setbacks or buffer zones need to be in place. Also, it may be possible to bench, terrace or otherwise stabilize the highwall.

b) For either a new or an existing operation it may be possible to backfill the excavation or selectively backfill the excavation.

c) If and when warranted and desirable reclamation blasting may be performed.

d) In many cases, the decision is to intentionally leave a highwall or partial highwall. If leaving a highwall is the option chosen there must be a demonstration that it is stable and safe. Also, the highwall should fit into the mosaic of adjacent land use, be compatible with the physical character of the area and be otherwise acceptable (permitted) from a zoning standpoint.

Also, when thinking about highwall proposals it may be wise to get a sense of relative risk that may be present. One way to do this is to consider the case of a highwall proposed to be left as is in a remote location versus other higher risk scenarios discussed below. A highwall left in a remote area that is surrounded by private lands, where agricultural land use (such as forage, row crops or forestry is in place) poses minimal safety risk provided there is little chance of recreational use by the public. However, the same highwall could be perceived as high risk if it is:

- located next to a subdivision and will soon be the site of a day care center; and
- located adjacent to or near public lands (additional safety concerns due to use of snowmobiles, ATV's or proximity to recreational areas where hikers, skiers or other recreational users might be exposed to risk.

## 2) Constraints That may Affect Mitigation Options

### Practical and economic

As a practical matter, when considering existing quarries, it is often very difficult or even impossible to completely eliminate or even to reduce highwalls (please see above discussion in Part 1 on setbacks and buffer zones).

Economically, either a setback from adjacent property lines (or from the limit of the deposit) or backfilling to achieve a desired slope are costly solutions. Either of these approaches would decrease profits and/or increase the cost of the project.

In the case of a planned **setback,** the mining operation and reclamation plan must be designed in light of a setback from either the property line or the limit of extractable nonmetallic resource material. This implies a decision to accept a loss of extractable material.

In the case of **backfilling** there may be substantial costs associated with obtaining and handling backfill material.

Discussions between the operator and the RA need to be open, thorough and non-adversarial in order that the best result can be obtained in each particular case. This is most likely if all the environmental and socioeconomic trade-offs are openly discussed. To be truly effective, this process must be done **before** mining begins, or **before** an expansion of an existing mine.

### Regulatory

In the case of pre-law mine sites (where no mining has taken place after the effective date of NR 135 standards - August 1, 2001) there is no legal basis to require mitigation under NR 135. For new mines or if mining occurred at pre-law mine sites after the effective date of NR 135, the standards of safety and stability apply.

Again, as a practical matter, in some cases, especially in pre-law sites (before August 1, 2001) mitigation may be limited or undesirable since the excavation ends right at the property line.

**Table 1.** Location of Information on Relevant to Highwalls

| FACTORS/ CONSIDERATIONS & THEIR APPLICATION | Reclamation Plan | Reclamation Standard | Other |
|---|---|---|---|
| *Determine degree of reclamation responsibility*<br><br>➢ New or reopened mine? Is part pre-law, i.e. no mining after effective date of rule?<br><br>➢ Continuing mining at (pre-law) minesite?<br><br>➢ Expansion of an existing mine? | NR 135.19 (2) (prev. mined areas)<br><br>NR 135.19 (4) (a) (slope stabilization)<br><br>NR 135.19 (4) (c) (final topography) | NR 135.05 (Applicability)<br><br>NR 135.06(3) (Publ.health, safety, welfare)<br><br>NR 135.10 (1) (2) (Safe & stable) | • NR 135.06(3) (publ.health, safety, welfare)<br>• NR 135.21 (2) Pre-law?<br>• NR 135.03 (16) site (25) Are there options and if so to what extent?<br>• PUBL WA-834 2002, Section III, p.7<br>• PUBL WA-834 2002 Section III, p.8<br>• PUBL WA-834 2002 Section III, p.15 |
| *Consistent with zoning*<br><br>➢ Land Use Plans or Zoning Requirements | NR 135.19 (3) (Post-mining land use) | | • NR 135.19 (3) (land use zoning)<br>• NR 135.19 (7) (approval)<br>• NR 135.21 (2) (new & reopened mines)<br>• NR 135.22 (denial criteria)<br>• NR 135.06 (15) (post-mining land use)<br>• PUBL WA-834 2002, Section I, pp. 2,3<br>• PUBL WA-834 2002, Section III, p.7<br>• HWSPEC Part 2 Question # 2 |
| *Safety & Stability as affected by:*<br><br>➢ Local geology<br>➢ type of mine | NR 135.19 (2) (a) (Geologic composition, site info.) | | • HWSPEC Part 2 Question # 3<br>• HWSPEC Part 2 Question # 4<br>• HWSPEC Part 2 Question # 5<br>• HWSPEC Part 2 Question # 6<br>• NR 135.06(3)<br>• (public health, safety, welfare)<br>• NR 135.10 (1) (2) (safe & stable)<br>• PUBL WA-834 2002, Appendix G, pp.44, 45 |

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**Table 2.** Location of Information Pertinent to Possible Highwall Outcomes

| POSSIBLE SOLUTIONS/ OUTCOMES | Reclamation Plan | Reclamation Standard | Other |
|---|---|---|---|
| **Reduce or eliminate** highwall | NR 135.19 (4) (a) (Final slopes & Stabiliz. Measures) | NR 135.10 (safe & stable condition) | HWSPEC Part 1<br>Part 3: Question # 2 |
| **Bench, terrace** or otherwise stabilize the highwall | NR 135.19 (4) (a) (Final slopes & Stabiliz. Measures) | NR 135.10 (safe & stable condition) | Part 2: Question # 5<br>Part 2: Question # 6<br>Part 3: Question # 1 |
| **Backfill** the excavation or selectively backfill the excavation | NR 135.19 (4) (a) (c) (Final topography) | NR 135.10 (safe & stable condition) | Part 1<br>Part 3: Question # 1 |
| If and when warranted and desirable **reclamation blasting** may be performed | | | Part 2: Question # 6 |
| **Intentionally leave a highwall or partial highwall,** demonstrate that it is *stable and safe*, and (in jurisdictions where applicable) show that the highwall fits in with the mosaic of adjacent land uses[1] | NR 135.19 (4) (a) (final slopes & stabilization. measures) | NR 135.10 (ID areas that don't need final grading) | Part 2: Question # 2<br>Part 2: Question # 3<br>Part 2: Question # 4<br>Part 2: Question # 5<br>Part 2: Question # 6 |

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[1]Consistency with local land uses plans and patterns and regulatory environment (where applicable). Consistency, while not defined in NR 135 and not a reclamation standard (again, legally a zoning matter) may include consideration of:

- How well does the proposed highwall fit into the local physical environment?
- Are rugged terrain features, natural escarpments, bluffs, or steep canyons found in vicinity?
- Would a safety hazard exist considering local land use patterns and population density, trends, etc.

## HIGHWALLS PART 4

### Summary and Final Thoughts: How to achieve "win-win" solutions
### Tom Portle

The NR 135 rule was the subject of years of discussion and problem solving. It is a reflection of the values and desires of a wide range of stakeholders as determined through a consensus process. The outcome of this process, NR 135, is meant to provide a balance between divergent viewpoints within the parameters established by the legislature. **In doing so NR 135 attempts to balance complex relationships among land use planning and zoning, property rights and regulatory authority discretion.**

One of the changes to NR 135 during the rulemaking process reflects the insistence on the part of representatives of county and municipal government that they maintain adequate **discretion** in program implementation. Indeed, this was in keeping with the legislative intent that there be **local control and flexibility** built into the code and local ordinances. At the same time, it was acknowledged that the post mining land use decision, as long as it is permissible under local land use plans and zoning, is typically made by the **mine operator/property owner**. If they are not one and the same it is ultimately the operator who is responsible to meet reclamation success standards driven by the post-mining land use. The combination of performance based reclamation standards customized to a selected target land use provides flexibility and encourages creativity. This, in turn, reflects the variability in geology and socioeconomic conditions found across the state.

Making decisions regarding highwalls is ultimately both a **land use decision** as well as a **stability and safety** issue. While the land use decision depends to a large degree on the existing zoning environment, the absence of zoning regulations should not be a reason to stop seeking creative solutions that may add value to the property, protect the environment or enhance public safety.

In most cases, the final land use will be enhanced by a creative and non-adversarial dialogue aimed at increasing both economic and other values attributable to the reclaimed mine site.

Ultimately, any land use decision is brought to fruition through a well-written and implemented reclamation plan. The highwall issue is often a critical part of the post-mining land use realized through the reclamation plan. It is best addressed with an intention to find a "win-win" solution - one that may add long-term value to the site. *Balancing property rights, future opportunities, environmental protection or enhancement, stability and public safety is best done with all parties seeking the best long-term solution*. The best solution is not always the easiest but it certainly is one that will add value to the property, providing long-term site stability, affording safety, while at the same time reflecting the local needs and desires.

**Figure 3.** Two equally valid but contrasting posting-mining land uses, which demonstrate how highwall reclamation can vary from wildlife habitat to a public park.