Department of Environment, Government of St Kitts and Nevis

Minerals Sector Study in St Kitts and Nevis

Good Practice Guide
Report for
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1. Introduction

1.1 Background

This report is delivered with respect to the original contract between the Government of St Kitts and Nevis (Department of Environment) and Wood Environment & Infrastructure Solutions (E&IS) UK Ltd (signed March 9th 2020) and the associated addendum signed April 7th 2021.

The scope of this report is further guided by the Inception Report (February 2021, Wood Ref. 42629-WOOD-ZZ-XX-RP-Z-0001_A_P01.2) and covers Tasks 3 and 4 of the project around best practice and rehabilitation.

The report builds on the Legislation and Policy Report (April 2022, Wood Ref: 42629-WOOD-ZZ-XX-RP-Z-0005_A_P01.3) which identified that greater clarity on the nature of conditions and good practice for the environmental management of quarries and sand mining sites would benefit the governments of St Kitts and Nevis to better implement existing legislative provisions for environmental control.

The report also draws heavily on the learning gleaned from the first project visit to St Kitts and Nevis, during which our project representatives (Ben Thomas and Nick Jarritt) were able to visit the majority of active quarrying and sand mining sites across the two islands. As part of this site visit, we were able to view examples of good practice already being implemented across St Kitts and Nevis, as well as identify areas where there is scope for environmental management to be improved.

1.2 Purpose of this report

The purpose of this report is to expand upon the environmental considerations set out in the Legislation and Policy report to provide description and examples of good practice in environmental management. The key considerations identified in that report are summarised in Figure 1.1.

Figure 1.1 Key considerations for the environmental management of quarrying and mining sites

<table>
<thead>
<tr>
<th>Definition of site and activity</th>
<th>Environmental Considerations</th>
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<tr>
<td>For all quarrying/mining activities it is important that there is a clear definition of the site and activity proposed, as required by the National Conservation and Environmental Protection Act.</td>
<td>Alongside the definition of site and activity, environmental considerations should also be included in permissions for quarrying and mining activities. These would normally be included within the Environmental Impact Assessment for the site, as required under the Development Control and Planning Act (St Kitts) or the Physical Development Control Ordinance (Nevis).</td>
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<tr>
<td>• Definition of proposed extraction area</td>
<td>• Site runoff and surface drainage management</td>
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<td>• Duration of extraction activities</td>
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<tr>
<td>• Volume to be extracted</td>
<td>• Waste management</td>
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<tr>
<td>• Depth of working</td>
<td>• Dust suppression</td>
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<tr>
<td>• Phased working</td>
<td>• Noise</td>
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<tr>
<td>• Topsoil and subsoil preservation</td>
<td>• Landscaping, restoration and aftercare</td>
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<tr>
<td>• Geotechnical considerations and facing angles</td>
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</table>
For each of these considerations, this report will:

- Provide further elaboration on good practice and its application in a Caribbean small island context
- Illustrate good practice through annotated examples based on sites across St Kitts and Nevis

### 1.3 Report structure

The report is set out as follows:

- Section 2 examines good practice with respect to the definition of sites and the activities to be performed
- Section 3 examines good practice with respect to the primary environmental considerations relevant to quarrying and sand mining activity in St Kitts and Nevis
2. Definition of site and activity

2.1 Introduction

For all quarrying/mining activities, it is important that there is a clear definition of the site and activity proposed (as required by the National Conservation and Environmental Protection Act). This is an essential foundation for good environmental management – by ensuring that there is absolute clarity on the boundaries of the site and the extraction activity planned, environmental management measures can be made specific and more clearly defined as well.

With respect to the definition of site and activity, the following considerations apply:

- Definition of the proposed extraction area
- Duration of extraction activities
- Volume to be extracted
- Depth of working
- Phased working plan
- Topsoil and subsoil preservation
- Geotechnical considerations and facing angles

2.2 Site definition

For all quarrying/mining activities it is important that there is a clear definition of the site and activity proposed (as required by the National Conservation and Environmental Protection Act). For all sites, the following information and conditions of operation should be clearly understood by both government and operators:

- **Definition of the proposed extraction area**: There should be no ambiguity about the area for which permission to operate has been granted. The spatial limits of extraction should ideally be identified on a map at an appropriately detailed scale (e.g. 1:10,000), including clarity of land ownership and/or the permission of land owners for materials to be extracted.

- **Duration of extraction activities**: Permissions for quarrying/mining activities should also be subject to a clear time limit on the duration of workings at the site (e.g. X years from the granting of permission). This allows a clear control point – a time by which activities must cease, or, if workable deposits remain at the site (within the defined extraction area), for a new permission to continue operation to be sought.

- **Volume to be extracted**: As assessment of the workable volume of material at the site, and the volume to be extracted, should be made prior to permission being granted. This should be appropriate to the area and duration of extraction activities. Alongside the definition of a total volume that can be extracted from the site,
consideration should also be given to limitation on the maximum extraction in any given year (or smaller time period as appropriate).

**Site selection**

Whilst land ownership and permission will set the maximum potential extent of any site, it is good practice to start to consider environmental factors from the initial point of the definition of the site extent. In determining the boundary or limits for extraction, consideration should be given to:

- Appropriate separation of the extraction activities from nearby land uses – buffer areas may be greater or lesser depending on the nature of adjacent land uses, but in all circumstances a sufficient buffer should be allowed.
- The siting of activities with respect to watercourses and surface drainage pathways – the most effective means of ensuring that quarrying or mining activities do not have an adverse impact on the surface water environment is to site activity away from watercourses or surface drainage pathways and ensure that activities will not stray into ghauts or their immediate drainage catchments.
- Minimising the potential for adverse impacts on adjacent receptors – sites should be located and the extent of extraction constrained to minimise dust, noise and visual impact to adjacent site. It is good practice to make use of the natural topography and vegetation to shield adjacent sites from adverse impact.

**Site access**

As well as the definition of the extraction area, consideration must also be given to the means of site access. Quarrying and mining activities can often be located some distance from major transport routes and require additional development of access roads/tracks. Site access also has the potential for adverse environmental impacts, and early consideration should be given to:

- Drainage, visibility proximity to neighbours, dust control and gradient
- The ability to maintain access tracks
- The impacts of changes in traffic movements on existing roads

Site security is also an important consideration in order to prevent unauthorised access and to ensure the safety of materials on site.

**Site definition checklist**

Table 2.1 provides a good practice checklist of the elements of site definition that should be provided in any proposals for new quarrying or sand mining activities. This can be used to supplement the information provided in the legislation and policy report to help support pre-application consultation and the assessment of planning applications for new quarrying or sand mining activities.
Table 2.1  Site definition checklist

<table>
<thead>
<tr>
<th>Site definition</th>
<th>Details to be considered</th>
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<tbody>
<tr>
<td>Definition of site area and surrounding receptors</td>
<td>• Map(s) of the site identifying the following:</td>
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<tr>
<td></td>
<td>o Land ownership and landowner permissions for extraction</td>
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<td></td>
<td>o Boundary of the area to be extracted</td>
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<td></td>
<td>o Any ancillary proposed development (e.g. site buildings, etc)</td>
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<td></td>
<td>o Identification of adjacent sites and all dwellings or other developments within 1km of the site</td>
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<td></td>
<td>o Identification of key environmental receptors in the vicinity of the site, such as ghauts, ponds, etc</td>
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<tr>
<td>Description of extraction approach and volumes to be extracted</td>
<td>• Description of the material to be extracted</td>
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<tr>
<td></td>
<td>• Description of the method of extraction and any ancillary processes, including the equipment to be used</td>
</tr>
<tr>
<td></td>
<td>• Total and annual tonnage of excavation</td>
</tr>
<tr>
<td></td>
<td>• Maximum extent and depth of excavation</td>
</tr>
<tr>
<td>Description of site access</td>
<td>• Plans for the means of accessing the site</td>
</tr>
<tr>
<td></td>
<td>• Description and design of any new access roads/tracks</td>
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<td></td>
<td>• Assessment of traffic volumes and impacts of additional traffic on existing roads and neighbourhoods</td>
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</table>

**Practical example: Canada Estate**

The quarrying operations at Canada Estate provide a good example of the importance of environmental considerations in the definition of site activity and the extent of excavation. The quarry at Canada Estate is located on the eastern coast of St Kitts, approximately 1km to the north of the eastern end of the runway at Robert L. Bradshaw International Airport. Although the site is well established and has been operated for a long time, it serves as a good example of the importance of a clear definition of extraction area with respect to a range of considerations. Figure 2.1 illustrates these considerations on an annotated plan.

**Impact on surface drainage and surface water body receptors**

To the immediate north of the worked area at Canada Estate lies a small ghaut or drainage channel, which drains to the east and into Greatheads Pond, which is located approximately 0.4km to the east of the Canada Estate quarry. The ghaut constrains the extent of working at the northern boundary of the site. Following good practice, an appropriate buffer zone from the site boundary should be allowed to ensure that activity does not impinge upon the ghaut channel.

**Visual impact of workings**

The southern limit of site working is constrained by the need to mitigate the potential for an adverse visual impact on the Basseterre valley. Excavation to the south of the site eats into a natural ridge line, shielding the airport and Basseterre valley to the south from the site. The southern boundary of the site is therefore constrained by the ridge line, and ensuring that excavation activity does not extend beyond this ridge is an important mitigation of visual impacts.
Impacts on other receptors

The eastern boundary of workings is constrained by the route of the St Kitts Scenic Railway, which runs from north to south through the wider Canada Estate. As an important cultural receptor, it is essential that the working of the Canada Estate quarry does not adversely impact upon the operation of the scenic railway.

Land ownership and permission

The western boundary of the site is constrained by land ownership. Although there is scope for extraction to extend a considerable distance further to the west / northwest of the existing activity, land ownership limits the area that can be worked.

Site access

There are two points of access to the Canada Estate quarry:

- The main access to the site from the highway, in the form of a paved access road to the eastern boundary of the site
A secondary access to the site from the highway further to the north, in the form of an unpaved track allowing access to the upper portion of the site at the western and southern boundaries.

The majority of traffic movements to and from the site are handled by the primary site entrance, where there is a sizeable junction with good visibility. Neither access road requires site vehicles to pass through a residential area.

2.3 Phased working plan

A phased working plan is a key component to minimising the disturbance and environmental impacts resulting from quarrying or sand mining activities, particularly for larger sites. Where a site is to be worked over a number of years, a progressive working programme should be proposed by the operator and agreed with the Government.

Phased working means the subdivision of the site into smaller areas to be worked and reclaimed successively. By operating a phased approach, the disturbance to the environment can be minimised and the progressive rehabilitation of the site after working accelerated. Key principles of a phased approach to site working include:

- Working of deposits in a systematic manner, generally across or downslope such that worked out areas can be rehabilitated without further disturbance
- Development of a systematic plan of benches or bays to be worked and rehabilitated in succession
- Minimising the disturbed area at any one time, ensuring that vegetation is preserved and not needlessly destroyed by brief activities
- Planning for the storage of waste rock and overburden in formally designed stockpiles and a plan to reuse this material in successive rehabilitation of worked areas.

Practically, a simple annotated map or diagram of the quarry indicating the subdivision of the site and the progression of extractions should be provided and agreed. Phasing plans representing the operation at given time periods representing critical stages in development should be prepared, accompanied by a schedule relating to the phases shown and covers the total and incremental volume and tonnage of material recovered, volume of spoil etc. Site planning is essential for efficient and cost-effective rehabilitation – rehabilitation planning should commence before site is opened up and focused on a well-defined end land use for the site.

Practical example: Lodge sand mining

The sand mining activity at Lodge provides a case study site for a practical consideration of what a phased working plan could look like. We must be clear, however, that this is a hypothetical example to illustrate the concepts described above and is not based on a real phased working plan for the site, nor is this a recommended phased plan for the site.

Figure 2.2 shows the Lodge sand mining site. The site is located on the east coast of St Kitts, approximately 1.5km to the north-east of Lodge village. The site is currently actively mined, with a digger on site extracting sand deposits and transferring sand to lorries for transport to buyers, such as St Kitts Masonry Products.
The site is accessed via a long track that crosses the St Kitts Scenic Railway, taking a sinuous path (to minimise gradient) down to the extraction site located by the coast at Grange Bay. Along the track are located a number of stockpiling, laydown and working areas where extracted material is stored. The worked area of the site is shown in Figure 2.3.

The site at Lodge provides a useful example of how a phased working plan could be considered for a site. This is presented as an indicative plan to illustrate the concept described above, rather than a specific recommendation for this site. Building on the key principles set out above, Figure 2.4 shows the development of the site in phases of operation, with commentary provided on each phase in turn.

In this example, the site is worked over five phases, extracting from the north-west corner of the site at the point of site access and progressively working to the south-east. The first phase of extraction creates the site working and turning area and provides access to the next phases of work. As each phase is completed, working moves to the next phase, with the site working and access area extended to maintain access to the active working area of the site.
Figure 2.3 Lodge sand mining site

Figure 2.4 Development of site phases

Undisturbed Site
The initial state of the site is undisturbed land, covered by the typical bush and scrub vegetation of the surrounding area. The maximum extent of working has been defined and the site access track laid down.
Phase 1
The first phase of working is to extract sand from the northern boundary of the site, closest to the site access point. This will create the primary working area for the site that can be used in subsequent phases for equipment storage and site access.

- Undisturbed area
- Active extraction area

Phase 2
The site will be worked from northwest to south-east. Having completed Phase 1 extraction, this area is converted to a site working area and Phase 2 extraction begun.

- Undisturbed area
- Active extraction area
- Site working & access

Phase 3
After the completion of extraction from Phase 2, this area can be prepared for restoration and rehabilitation. Phase 3 extraction is begun and can be accessed from the site working area with no need for disturbance of the Phase 2 area.

- Undisturbed area
- Active extraction area
- Site working & access
- Worked area
As each phase of the site working is completed, the worked area can be prepared for rehabilitation and then progressively restored alongside the continued working of the site, thus minimising the environmental disturbance of the sand mining activity. Progressive restoration is discussed further in section 3.8, where this example is extended to further discuss good practice with respect to progressive restoration.

### 2.4 Topsoil and subsoil preservation

Quarrying and sand mining activities will normally require the removal of topsoil and subsoil, and potentially additional overburden. This material is a valuable resource for the successful rehabilitation of sites after use and, as such, should be retained. Ideally, this should happen as part of a phased rehabilitation plan (see above), thus avoiding the long-term stockpiling of material.

Where topsoil/subsoil is stockpiled, there are a number of recommended good practices that should be applied:

- Handling of topsoil should be kept to a minimum – this is a valuable resource for rehabilitation and should not be buried or driven on in order to avoid compaction
- Stockpiles should be placed away from traffic, watercourses and sources of pollution
• Drainage measures should be installed to allow drainage through and around large
  stockpiles (see Chapter 3)
• Growing vegetation on stockpiles can be an effective measure to reduce erosion and
  maintain biological activity within the soil, although this will need to be monitored for
  weeds and invasive species.

Ideally, stockpiles should be restricted in height to 3m for topsoil and 5m for subsoils. The
handling of wet soils should be avoided to avoid compaction.

2.5 Geotechnical considerations

Quarries should be carefully designed such that the landform poses no slope failure, slumping or
collapse risk to employees or the public. Natural instability should be minimised by setting a face
orientation which optimises stability while minimizing the induced stability by adopting an
appropriate method of excavation.

All quarry workings will include slopes of varying nature, either in the excavations themselves or
formed from fill material. Each slope formed within a quarry should be designed, constructed, and
managed to ensure that it remains in a safe and secure position. These include short (stockpiles
and soil mounds), medium (soil mounds, quarry faces, and screening bunds etc.) and long-term
slopes (quarry faces, spoil mounds, and screening bunds etc.). It is critical that a quarry is designed
taking into account the major factors affecting stability.

There are three primary constraints affecting the stability of excavated slopes:

• Properties of in situ material;
• Incidence and properties of discontinuities, and;
• Groundwater conditions.

Additional external factors may also influence the stability of excavated slopes and should also be
considered. These include the impact of loading from spoil and machinery, vibrations due to
processing or earthquakes and the effect of additional engineering activities.

Accumulations of materials in quarries result in fill slopes (spoil heaps, stockpiles and backfilled
areas). There are a range of factors that contribute to the stability of fill slopes:

• Properties of materials in and beneath the slope;
• Structure of the slope and its foundations;
• Water pressures within the slope, and;
• External influences.

The angle of working faces should be determined by the nature of the material. There are some
rough guidelines to be considered:

• Clay should have an overall slope of no greater than 1:1
• Sand should have an overall slope of no greater than 1:1.5
• Vertical faces should be less than two metres
3. Environmental considerations

3.1 Introduction

The existing legislative and policy landscape in St Kitts and Nevis contains structured, clear and strong provisions to manage the environmental impacts of the extraction of sand, gravel and stone. In particular, there are strong regulatory and policy processes in place for development control, including EIA requirements that are explicitly linked to quarrying/mining as an activity requiring EIA. This gives good provision for the government to impose suitable controls when considering new quarrying activity. However, our observations and learning from this project are that:

- EIAs need to become a more meaningful part of the development control process in order to be effective; and
- There is a potential gap in supporting documentation to allow the government to effectively assess EIAs and/or for operators to know what mitigation should be included.

The Legislation and Policy Report (April 2022, Wood Ref: 42629-WOOD-ZZ-XX-RP-Z-0005_A_P01.3) identified a range of environmental considerations that are particularly relevant to the environmental management of quarrying and sand mining activities in St Kitts and Nevis. This section provides additional detail on good practice measures, illustrated with examples from sites across St Kitts and Nevis. This should not be interpreted as an exhaustive list for all quarrying or mining EIAs, however – other environmental factors may be relevant as a result of other drivers (e.g. traffic impacts on local communities, depending on the location of the activity) and should be included in EIAs as required.

As part of determining the scope for an EIA for any particular site/application, pre-application engagement is strongly encouraged. We understand from our discussions with the Government administrations of both St Kitts and Nevis that pre-application engagement is standard practice and promoted as much as possible (although there are always applicants that do not wish to engage) – this is an important principle to maintain and embed for quarrying and mining activities as well.

3.2 Surface runoff and drainage management

Quarrying and mining activities have significant potential to lead to problems with respect to surface runoff and land drainage where not managed effectively. Site runoff has the potential to mobilise significant quantities of sediment from quarrying/mining sites, leading to water quality issues in downstream receiving water bodies (e.g. ponds) or the nearshore environment. Runoff also has the potential to mobilise pollutants from the site. As such, effective drainage and sediment capture is a fundamental requirement for all sites, covering:

- Drainage and erosion control
- Water storage and sediment control
- Water quality and pollution control
Drainage and erosion control

At a headline level, all quarrying and sand mining sites should be able to demonstrate how the activities will ensure no interference with or pollution of surface water bodies or the marine environment. To achieve this, it is important that there is consideration of both the impact of the site on the wider topography and drainage of the surrounding area, and the handling of runoff and drainage within the site itself.

Impacts on wider drainage systems and topography

An understanding of the impact of quarrying and sand mining activity on the wider topography and natural drainage network is essential to managing surface runoff. Extraction activities have significant potential to alter topography and, as a result, affect the flow of water across the land surface – this is particularly important in the context of Caribbean sites, where rainfall events can be intense, resulting in significant volumes of surface runoff with a high potential for erosion and sediment transport.

Quarrying and mining activity should be located away from ghauts to ensure that they are not removed, damaged or polluted – in line with the requirements of the National Conservation and Environmental Protection Act. This will ensure that quarrying activity does not make significant alterations to major flow pathways. Where existing extraction activity extends close to existing drainage pathways and/or ghauts, close attention must be paid to the management of runoff.

Practical Example: New River 2 (Nevis)

As a practical example, the Lefco quarry at New River 2 on Nevis is located in very close proximity to a number of drainage pathways. Figure 3.1 shows a schematic of the New River 2 site, indicating where location of the site with respect to a number of ghauts that pass close to the site boundaries.

There are two points of concern where extraction has extended very close to ghaut channels to both the north and south of the quarry:

- To the north, the ghaut is located at a higher elevation, above the quarry. The track that provides access to the upper levels of the quarry passes very close to the ghaut channel, as illustrated in Figure 3.2. This is a particular concern as the ghaut is perched above the level of the quarry – during heavy rainfall events, significant flow in the ghaut could easily overspill the low bank to the access track, and any flow coming out of the channel at this point is likely to flow over the track and cascade into the quarry, potentially leading to flooding and erosion within the quarry site, exacerbating site runoff and entrainment of sediment.

- To the south of the quarry, the edge of the worked area extends close to the incised channel of another ghaut. This ghaut is situated at a lower level to the quarry – it is highly unlikely that this ghaut could cause flooding of the quarry, but the proximity of the southern boundary of the quarry to the channel increases the potential for quarrying activity to adversely impact the ghaut. This could be as a result of uncontrolled runoff from the quarry entering the ghaut, or progressive erosion of the ghaut channel. A view from the southern boundary of the quarry into the ghaut channel is shown in Figure 3.3.
Figure 3.1 Drainage pathways around the New River 2 quarry

Figure 3.2 Ghaut channel above the New River 2 quarry
Given the topography of both St Kitts and Nevis, every potential quarrying or sand mining site will have the potential to intersect or impact upon existing drainage pathways and ghauts. Direct working that affect ghaut channels should be avoided (in line with the requirements of the National Conservation and Environmental Protection Act). Close attention should be paid to the proximity of working to any channels, including consideration of how working may affect water running onto the site, and how runoff from the site may affect local drainage.

On-site drainage and erosion control

As well as considering the wider topography and drainage context, sites must also manage on-site drainage to prevent erosion and ensure runoff does not contaminate off-site areas or waterways. There are three main components to good practice for on-site drainage and erosion control:

- Minimising disturbed areas to reduce the potential for erosion and entrainment of sediment:
  - Working sites in discrete stages, in line with a phased extraction plan, so that exposed areas are kept to a minimum at any given time
  - Limiting the areas to be disturbed by machinery operations and ensuring that these are clearly marked – heavy plant and vehicles will compact surfaces, reducing infiltration and increasing runoff
- Stabilising disturbed land as soon as possible

- Implementing drainage measures to control and route runoff
  - Managing the topography of the site to route and control drainage
  - Planning and implementing a site drainage strategy, including the use of cut-off drains and bund walls to intercept and direct surface runoff away from disturbed areas
  - Minimising surface runoff through control of gradients for access tracks, as well as installing regular cross-drains or culverts to intercept runoff

- Water reuse
  - Considering capture of runoff for other uses on site – for example, recycling water for dust control or watering vegetation (in areas being rehabilitated)

**Practical Example: New River 2 (Nevis)**

The New River 2 site also provides a practical example of good practice in the management of site drainage and runoff.

Within the quarry, the drainage is managed in two different ways. In the upper area of the quarry, the topography of the site routes any surface runoff towards a basin area to the north of the site where extraction activity has ceased and vegetation is re-establishing. This is an effective way of minimising site runoff and ensuring that any entrained fine sediment is retained on-site and not conveyed to receiving downstream watercourses. The routing of water to this area will also help promote vegetation re-establishment and re-growth.

The lower area of the quarry, towards its eastern extent, drains towards a series of settlement ponds that have been created by the quarry operators to capture runoff and allow fine sediment to settle, before water is discharged to the ghaut channel downstream of the site. Shallow bunds are used to help route surface runoff towards these settlement ponds and minimise any direct runoff from the site via other routes. The location of the ponds is highlighted in Figure 3.1, above.

The siting and use of these settlement ponds is a strong example of good practice – they are located at the lowest point of the site, runoff is actively routed to them, and the ponds are set up to operate in series before a controlled point of discharge to the ghaut channel downstream of the site.

Figure 3.4 illustrates the drainage pathways in the New River 2 quarry. Viewed from the upper tier of working of the quarry, the drainage of the upper area of the site to the area of vegetation re-growth can be seen in the foreground, with the lower area of the site highlighted in the background.
Figure 3.4  Overview of drainage pathways in the New River 2 quarry

Sediment control and water quality

Sediment control

Site runoff has the potential to mobilise significant quantities of sediment from quarrying/mining sites, leading to water quality issues in downstream receiving water bodies (e.g. ponds) or the nearshore environment. Runoff also has the potential to mobilise pollutants from the site.

Figure 3.5 illustrates the impact of sediment runoff from stored material into Greatheeds pond, St Kitts. In this example, stockpiled material is stored in the immediate vicinity of the pond – this material includes waste material from gravel washing on the site, as well as stockpiled sand for use in making concrete blocks. Insufficient runoff control is resulting in runoff from these stockpiles into Greatheeds pond, resulting in a growing alluvial fan extending into the pond.
Any runoff from working areas (and water from washing, screening, etc) should be collected in settlement ponds before being discharged from site. This is typically achieved through the use of settling ponds, filter strips, or (on larger sites) constructed wetlands designed to trap sediment before water is discharged from the site. For the scale of quarries in St Kitts and Nevis, settlement ponds would typically be the most appropriate method for sediment capture.

Good practice for the management of effective settlement ponds includes:

- Designing to an appropriate standard to address high rainfall events – for example, in the Caribbean it would be appropriate to design settlement ponds to be able to effectively operate up to the 10% Annual Exceedance Probability (AEP), equivalent to a 1 in 10 year event.
- Ensuring discharge from settlement ponds into natural, vegetated drainage lines via properly constructed spillways to prevent erosion.
- Ponds should be regularly maintained, including removal of captured sediment. Their effectiveness should be monitored as part of a surveillance and management plan.

With respect to managing the runoff of fine sediment from quarrying/mining sites, techniques such as settlement lagoons can be effective in capturing sediment entrained in site runoff before it discharges from the site – but measures should also be taken to minimise the entrainment of fine sediment in the first place. These measures can include:

- Locating stockpiles well away from drainage pathways, channels and drains
- Ensuring slope stability and limiting the size/height of stockpiles to reduce direct runoff and fine sediment loss
- Managing stockpiles within siloes or bunds to reduce runoff and sediment entrainment

Practical Example: Settlement ponds at St Kitts Masonry Products

A good example of the use of settlement ponds to remove fine sediment can be found at St Kitts Masonry Products, Canada Estate. Figure 3.6 illustrates the sediment ponds capturing sediment from the gravel sorting and washing plant that operated on-site by St Kitts Masonry products. Runoff from this plant is channelled via a short informal swale to a series of settlement ponds. In this photo, sediment-laden runoff from the gravel washing enters the ponds in the bottom-left corner of the photo. Water is then routed through six ponds, before being pumped from the ponds into Greatheeds pond, via the pumping equipment that can be seen in the background of the photo.

This is a good example of the effective use of settlement ponds. It is also, however, an example of how good practice measures can be easily undermined by poor practice – the settlement ponds are situated between the two stockpiles highlighted in Figure 3.5, direct runoff from which is leading to sediment accumulation in Greatheeds pond.

Figure 3.6 Example of settlement ponds at St Kitts Masonry Products
Pollution prevention

In order to prevent pollution as a result of surface runoff from quarrying/mining activities, consideration should be given to measures to remove and control potential sources of pollution, and to measures to intercept pollution vectors from the site. These measures can include:

- Ensuring that sources of potential contaminants (e.g. oil/fuel stores) are sited on impermeable surfaces and surrounded by bunds to prevent pollution runoff
- Use of Sustainable Drainage Systems (SuDS) to minimise pollutant transportation, such as:
  - Filter strips – vegetated sections of land designed to intercept overland flow and remove excess sediment and pollutants before discharging from the site
  - Swales – grassed shallow depressions to intercept and convey runoff, effective at retaining sediment and oily residues
  - Filter drains – excavated drains, backfilled with coarse stone, to intercept and store runoff

As well as aiming to control pollution on-site, good practice will also include regularly checking for environmental impacts off-site. For example, regular checks should be made to ensure that the drains or ghauts into which site runoff is directed are not more visibly turbid, are not accumulating additional fine sediment, and are free from oil or other pollution.

Practical Example: Fine sediment downstream of New River 2 (Nevis)

An example of quarry-related sediment being found in a ghaut channel downstream of a quarry was found at New River 2 (Nevis), where there is some qualitative evidence of additional fine sediment being washed down the ghaut below the quarry, as shown in Figure 3.7.

A walkover of the ghaut channel at its outflow to the sea found areas of fine sediment deposit as the channel gradient reduced as it reached the beach. Similar fine sediment was not found in adjacent ghaut channels that do not drain from the quarry, indicating that the fine sediment is likely to be associated with runoff from the quarry. This would be expected and it is stressed that this example is not provided as an example of bad practice at the New River 2 quarry – the quantity of sediment in the ghaut is relatively small, and deemed to be insignificant, or at worst minor, in its impact on the nearshore environment (the visible suspended sediment in the sea along this stretch of coast is a result of erosion of fine sediment from the cliffs in this area, rather than outflow from ghauts). It does, however, provide a useful example of how easily fine sediment can be entrained and washed downstream from quarrying and sand mining sites.
3.3 Groundwater protection

Quarrying and mining activities have the potential to affect underlying aquifers by removing filtering superficial deposits, or by excavating into an aquifer and creating a direct pathway for pollution of groundwater. Although the hydrogeology of St Kitts and Nevis is such that it is unlikely that quarrying or sand mining activities would take place in locations coincident with aquifers, the importance of groundwater for water supply is such that consideration of groundwater impacts should not be ignored. Quarrying activity should not result in any interference with or pollution of groundwater. This should be demonstrated by an EIA for any new permissions being considered.

The most effective means of ensuring that quarrying or mining activity does not impact groundwater is to avoid active working in deposits above or containing groundwater aquifers – although it is unlikely that this scenario would arise in St Kitts and Nevis because of the existing protection given to aquifers critical to water supply (e.g. the Basseterre Valley Aquifer).

Pollution of groundwater can come from the infiltration of surface water and contaminants through permeable overlying strata, or through direct interception of an aquifer as a result of excavation of the quarry below the water table. As a minimum, all sites should ensure that:

- Disposal or tipping of effluent or polluting substances (e.g. oil or fuels) is prevented and controlled to ensure no risk of discharge to groundwaters
- Excavation does not intrude into designated aquifers or result in any excavation below the water table

Figure 3.7 Fine sediment in the ghaut downstream of New River 2 Quarry
There are two main ways that pollution reaches groundwater:

- Point source pollution – this comes mostly from spills, leaks and discharges at a single point or over a small area. Point source pollution is often easy to identify because it results from isolated events or activities.
- Diffuse pollution is the cumulative impact of small, undefined pollution events and general environmental pollution spread over the catchment area.

Managing spills and storage of potentially polluting materials

Point source pollution is the most significant risk from quarrying or mining activities and it is essential that controls are in place to prevent spills, leaks and discharges of hazardous or polluting substances. The biggest risk of spills is likely to come from re-fuelling or maintenance of vehicles – this should ideally be done off site, or if done on site should be undertaken within a bunded area on an impermeable surface, with facility to capture and safely dispose of any spills.

Risk of groundwater contamination should be minimised through the following good practice measures with respect to the storage of potentially polluting or hazardous materials:

- On-site fuel storage should be in above-ground, bunded facilities in preference to underground fuel tanks
- Fuel storage areas should be located away from waterways and areas prone to flooding
- Hazardous materials management procedures should be established, including emergency response plans, with site personnel trained in those procedures
- Regular inspection of all bulk containment and effluent holding tanks
- Ensuring appropriate impermeable surfaces beneath stationary machinery to minimise the risk of pollution from any leaks
- Ensure drainage from areas where spills may occur is diverted through a sump or interceptor trap
- Spill kits containing oil absorbent materials should be on hand to ensure any oil or grease spills can be captured

Excavation below the water table

Although unlikely to be permitted in St Kitts and Nevis, where excavation is proposed below the water table, hydrogeological studies should be carried out to establish the likely impacts to flows in the surrounding areas. Where excavation breaches the water table, dewatering will be required to prevent the water ingress into the excavation. This abstraction of groundwater can impact surrounding groundwater levels, and will require appropriate disposal via site drainage (see above). Subsequent groundwater rebound can lead to a change in hydrogeological regime and flooding of the excavated area, bringing challenges for appropriate rehabilitation.

Given the geology and hydrogeology of St Kitts and Nevis, excavation into aquifers, particular where these are important for water supply, is strongly recommended to be avoided – in line with the protection already afforded to these aquifers.
3.4 Waste management

Quarrying and mining activities have the potential to create significant quantities of ‘waste’ material as a result of extraction and processing. All activities should have a plan in place to minimise, treat, recover and dispose of extractive waste. Through effective planning, waste materials can often be minimised, stored on site and then re-used in the restoration or rehabilitation of the site at the end of its working life. Wherever possible, however, all material extracted should be used, and there is plenty of good evidence of this happening at sites across St Kitts and Nevis.

Key considerations for extractive waste are:

- Whether extractive waste is inert, non-hazardous but non-inert, or hazardous. For the majority of locations in St Kitts and Nevis extractive waste would be expected to be inert, and non-hazardous, but this should not be taken for granted
- How waste will be created, treated and stored:
  - What is the expected volume of waste material that will be created?
  - Does the material need to be treated in any way to avoid risk of pollution or contamination?
  - Where will the material be stored and how will this be done in a way that avoid the risk of pollution (see sections above regarding surface water management and runoff)?

These considerations should be addressed through waste management planning, backed up by implementation of appropriate measures to store and re-use waste materials.

Waste management planning

It is good practice for all quarries and sand mining sites to prepare and enact a waste management plan to outline the approach to be taken to minimise, treat, recover, and dispose of all extractive waste. A typical waste management plan should set out the approach to be used to:

- Minimise overburden to maximise efficiency, and use to progressively infill areas where applicable
- Re-use and recycle materials such as clay and silt recovered from settlement ponds
- Securing the site perimeter, or taking other measures to ensure there is no illegal dumping – quarry sites can be attractive to illegal dumpers for disposal of household or industrial waste, particularly once active working of a site has ceased
- Store waste material in a neat and tidy manner, with stores emptied on a progressive basis before overflowing
- Ensure that all hazardous waste is disposed of on a progressive basis using the appropriate disposal facilities
Waste material handling

Overburden material and/or topsoil that is extracted should be retained and stored on site to be used in the rehabilitation of the site once extraction activities are completed. If stockpiled waste material being stored on site is capable of supporting vegetation, this should be promoted to assist with the stability of the stockpile, minimise loss of material with surface runoff, and to reduce the visual impact of the stockpile.

Good practice measures for handling waste material include:

- Pre-sorting and selective handling of extractive materials
- Recycling of by-products
- Ensuring appropriate drainage of stockpiles, including measures to capture sediment runoff (see sections above)

As a general principle, waste extractive material should be used in site rehabilitation wherever possible. In combination with a phased working and rehabilitation plan, the need to store waste material on site for long periods of time can be significantly reduced, thereby reducing the likelihood of other potential adverse effects from the storage of waste materials.

Tailings management

Tailings, the fine-particle residues from mineral processing which are generally disposed of as a slurry to tailings dams, can have considerable pollution potential, depending on the particular mineral involved and the processes used. Where tailings are produced, these must be closely managed through capture behind a tailings dam, giving due regard to:

- The safety and stability of the dam and retention of material behind it
- The possibility of seepage
- The visual impact on the surrounding landscape
- The treatment and discharge of water and control of pollution risk to downstream water bodies

Based on our observations, the quarries visited in St Kitts and Nevis do not produce a significant volume of tailings material, only the waste runoff from washing that takes place on site. For example, at the Lefco quarry at New River in Nevis settlement ponds are used to remove fine deposits from washing, as shown in Figure 3.8.

Particular attention should be given to the storage of fine materials recovered from settlement ponds – if left in unmanaged stockpiles, fine material can very easily be eroded and transported by rainfall and run off from the quarry site.
3.5 Dust suppression

Dust can pose an environmental challenge for quarry/mining sites in two ways:

- Impacting the health of workers at the site – respiratory conditions, such as silicosis, can be debilitating and are irreversible after prolonged exposure, and there are also proven links between exposure to dust and the occurrence of lung cancer.
- Impacting the wider environment in the vicinity of the site, exposing those living or working close to sites to dust.

Suppression of dust

The primary means of reducing the environmental impacts of dust is to apply techniques to suppress the generation of dust. Good practice approaches can include:

- Use of spraying and watering techniques to minimise dust creation, such as:
  - Spraying water as a fine mist over the source of the dust emission, usually at the point of extraction or crushing, ensuring particles are trapped in water droplets and can be managed through drainage control on site;
  - Dampening of loads on transport trucks
  - Watering of vehicle tyres as they leave site
  - Watering of access roads
- Use of surface binding agents applied to stockpiles – including vegetation for stockpiles of waste material stored on site to be used in rehabilitation

Figure 3.8 Settlement ponds at New River 2, Nevis
Covering of truck loads during transportation
Consideration of prevailing wind direction and use of vegetation as wind breaks to minimise dust mobilisation
Progressive revegetation to minimise exposed areas.

**Personal Protective Equipment**

The health and safety of site workers should be protected through the use of appropriate Personal Protective Equipment (PPE) to minimise dust inhalation. This should include respirators/masks, coveralls and gloves. PPE should only be considered as a control measure of last resort – priority should always be given to techniques to suppress dust and minimise the exposure of workers.

Evidence of PPE being used at quarries in St Kitts and Nevis was observed during the project field visits, as illustrated in Figure 3.9, although this was not consistent across all sites and all personnel.

**Figure 3.9** Worker in PPE to minimise dust inhalation

### 3.6 Noise

Quarrying and mining activities can give rise to considerable noise and this will be a major consideration where working is proposed close to dwellings or other noise-sensitive properties. Good practice measures to minimise the disturbance impacts of noise from quarrying and mining activities include:
- Ensuring an appropriate buffer distance between the quarry site and receptors, such as residential properties, that may be impacted – ultimately, the best way to avoid noise impacts is to site the activity away from noise-sensitive properties

- Consideration of the prevailing wind direction and avoiding siting noisy plant downwind of noise-sensitive properties

- Consideration of the siting of noisy equipment to allow for mitigation of noise impacts – for example, siting noisy equipment in one area of the site and making use of natural topography and other mitigation to reduce noise impacts

- Restricting hours of operation to minimise impacts – for example, restricting activity to avoid weekends and early mornings, evenings, etc

- Use of barriers/screens to shield noisy machinery and minimise noise disturbance

Measures can also be taken to minimise the noise generated by machinery:

- Noise suppressors should be fitted wherever applicable

- Machinery should be properly maintained to minimise noise during operation

- Access tracks and haul roads should be maintained to minimise corrugations

Quarry sites should also actively work to be ‘good neighbours’ and provide advance notice when particularly noisy activity is to be undertaken – in particular, notice of any blasting should be provided in advance to nearby properties that may be affected by noise from blasting activity.

Noise also has health and safety implications for site workers. It is important that appropriate occupational health and safety systems are in place to monitor and control employee exposure to noise and vibration, and to reduce exposure times for people working near noisy machinery.

### 3.7 Site landscaping – minimising visual impacts

Quarrying and mining activities may be visually out of proportion with surrounding areas and measures should be taken to minimise their visual intrusion on the landscape, and to restore sites to more natural states following the cessation of extraction activities.

Quarrying and sand mining activities can be visually intrusive and impact highly on the natural landscape of St Kitts and Nevis. The ideal strategy is to seek to prevent/avoid significant visual intrusion – this is primarily achieved through site selection and design to ensure that the worked area is hidden or shielded within the landscape, making use of natural topography to screen sites from public view. There is good evidence of this consideration being made for sites in St Kitts and Nevis – for example, at Canada Estate a key limitation on the working area is the ridge line on the western boundary of the site. This ridge shields the quarry from view from Basseterre valley, thus maintaining the views and visual aesthetic in this more populous area, ensuring that the quarry is not visually intrusive.

Having considered the overall siting of the quarry, effort should be made to minimise the visual impact on the landscape through emphasis on scheme design to ensure that the levels, working and management of the site does not exacerbate visual impact on the landscape.

When planning sites, it is good practice to give consideration to:
• Planning the direction of working so that the worked face is shielded from the most critical views and seeking to ensure that the quarry/mine site is hidden from neighbours or other sensitive land uses

• Making use of natural topographic features and vegetation to screen areas of working. Clearance of surrounding vegetation should be minimised, and consideration should be given to, for example, tree planting to provide additional screening

• Avoiding locating new quarrying/mining activities adjacent to busy roads and sensitive receptors

Having taken measures in site planning to prevent/avoid visual impacts, focus should then switch to measures to reduce the remaining visual impacts of the site as much as possible through scheme design. Operational measures to reduce visual impacts can include:

• Working uppermost benches first and rehabilitating as soon as possible after working (uppermost benches will be most visible from the furthest distance from the site)

• Ensuring vegetation for rehabilitation is compatible with surrounding vegetation or sourced from local native stocks

• Using landscaped mounds to conceal unsightly excavations, designing the size and shape of bunds to blend into existing landforms

• Minimising exposed areas through progressive restoration

• Maintaining buffer zones between the site and neighbouring properties

• Consideration of the location and design of site buildings to minimise visual intrusion.

3.8 Site restoration

Once extraction activities have ceased, quarrying/mining sites should be restored as close as possible to a natural state. The requirements for restoration should be set out in the initial permissions for a site to be worked and should cover:

• Site clean-up – ensuring that the operation of the site is appropriately decommissioned

• Landscaping – reshaping the landform to an appropriate topography for the post-working life of the site

• Re-vegetation – providing self-sustaining cover consistent with the final land use

Site clean-up

The initial step in site restoration is the full decommissioning and clean-up of the operational site at the end of its working life. This should include:

• Removal of all machinery, infrastructure and waste materials

• Breakup or burial of concrete slabs, loose rock, etc

• Rehabilitation of an hardstanding areas, surplus roads/tracks, etc
At the end of its working life, the site should be describable as “decommissioned” rather than “abandoned” and the quarry operator, whether government or private, should recognise their role in the restoration of the site.

**Landscaping**

An important part of rehabilitation and restoration of quarrying and mining sites is to reshape the final landform to an appropriate topography for the post-working life of the site. This is primarily to ensure the safety of the site and its appropriate preparation for re-vegetation. Ideally, the final intended landform should be set out as part of the site planning process before working is begun.

In reshaping the site topography to blend into the surrounding landscape, consideration should be given to:

- Regrading or levelling of any residual stockpiles that are not intended to be removed from the site
- Reducing the slope of erodible surfaces to a gradient of no more than 1:3
- Regarding any overburden to push material into hollows and level the site

Smooth or compacted surface should be ripped or ploughed to improve the roughness of the site and promote vegetative growth. The final site should be left stable and free-draining, blending into the surrounding landscape.

Once a stable landform has been re-established, topsoil can be re-spread evenly across the site to a suitable depth, ideally avoiding importing topsoil from other sites as this may contain seeds of weeds and non-native species.

**Re-vegetation**

After the site has been landscaped, the final step in restoration is to establish a self-sustaining vegetation cover that protects the site and is consistent with the final land use. Re-vegetation should be planned and targeted to create the final intended landscape, with appropriate measures including:

- Using seeds of native vegetation to blend with surrounding areas
- Using a combination of seeding and direct planning of seedlings to encourage rapid establishment of cover
- Considering faster-growing species on steeper slopes to stabilise the soil whilst other plants become established
- Applying mulch or fertiliser where needed

Preventative steps should be taken to minimise pest animal browsing or disturbance of the site to allow vegetation to be established as rapidly as possible, for example through perimeter fencing. This is also important in providing security to prevent illegal dumping, which can be a problem in recently decommissioned quarrying sites.

Erosion prevention is critical during restoration – there is a risk that poor drainage management can damage rehabilitation workings. The best form of erosion management is to successfully re-
vegetate, although during the process of re-establishment, other measures of erosion control may be required. This could include retaining existing site drainage controls and sediment ponds to slow down runoff.

The timing of revegetation is important – both with respect to allowing vegetation to re-establish rapidly, and in minimising erosion. Preparatory earthworks and landscaping should be undertaken during drier months to reduce the risk of erosion, and planting undertaken at the most appropriate time for successful germination.

**Reforestation of abandoned quarry at Potworks Estate**

The majoring of the sites across St Kitts and Nevis that were visited during the field visit were operational sites, however there was the opportunity to visit the IWEco site at Potworks Estate, where work is being undertaken to rehabilitate an abandoned quarry site.

The Potworks Estate site is located on the north-east coast of Nevis, just to the north of Hicks Village. Under the IWEco project, and with the support of the Department of Environment and the Nevis Island Administration, the site is being restored to reduce land degradation and help to remediate the abandoned quarry workings.

**Site clearance**

The Potworks site is truly an abandoned quarry – there is still a considerable amount of equipment and machinery on site that was not decommissioned as part of the closure of the site, as illustrated in Figure 3.10.
There is evidence that machinery has been scavenged for parts in many cases, leaving residual equipment that is now very difficult to remove from the site. This illustrates the importance of ensuring that sites are fully and safely decommissioned at the cessation of working to ensure that they are appropriately cleared and cleaned prior to rehabilitation.
Landscaping

As the site is being rehabilitated, some work is being undertaken at the Potworks Estate site to landscape areas at the entrance of the site to stabilise slopes and promote vegetative regrowth. This is being effectively delivered through the use of unused boulders and large stones from the quarry to create a terraced area where trees have been planted – over time, this should begin to screen the quarry from nearby residential sites. The preparation of terraces for landscaping can be seen in Figure 3.11, below.

Figure 3.11 Landscaping at Potworks Estate restoration

Re-vegetation

Alongside landscaping works, extensive planting is being undertaken to allow the site to revert to a more natural state. Given the climate of St Kitts and Nevis, vegetation will rapidly recolonise undisturbed sites anyway, but this can also be supported through targeted planting to promote
particular species of types of plant, as is being done at Potworks Estate. Figure 3.12 shows examples of vegetative re-growth at Potworks Estate, illustrating how the former quarry is gradually being re-integrated into the natural landscape of Nevis.

**Figure 3.12 Vegetation re-growth at Potworks Estate**

Challenges

The site restoration example at Potworks Estate illustrates several examples of good practice in restoring an abandoned quarry, but also serves to highlight some of the challenges associated with site rehabilitation. As noted above, the working legacy of the site is reflected in a significant amount of abandoned infrastructure on site that was not cleared when the quarry ceased working, posing some challenges for the restoration of the landscape. In addition, the site has experienced illegal dumping, as illustrated in Figure 3.13. Site security during rehabilitation should ideally be put in place to prevent illegal dumping wherever possible, although this may not always be practical for larger sites.
Progressive rehabilitation

The most effective approach to minimise environmental impacts from quarrying/mining activity is to work and restore sites progressively – as each area of the site is worked for extraction, it should be restored whilst new areas of the site are worked. This approach minimises the total disturbed areas and allows overburden and topsoil to immediately contribute to restoration rather than need to be stored. Progressive rehabilitation should be included as part of a progressive working plan for the site.

Practical example: Lodge sand mining

In Section 2.3 of this report the Lodge sand mining site was used as a practical example of a phased working plan. This example is extended below to illustrate the principle of progressive rehabilitation – as an extraction phase is completed, the area is immediately rehabilitated and restored to its final intended state in parallel with the continued working of the site. In practice, this means that at any given time, both extraction and restoration activities are being undertaken, progressively returning the site to a more natural state over the lifetime of working, thereby minimising environmental disturbance.

Figure 3.14 shows the progressive working and rehabilitation of the site across nine steps, from the initial undisturbed state of the site, through to the final fully-restored site. The example uses the same five extraction phases as used in section 2.3.

The parallel activities on site are indicated in Table 3.1 below the figure, showing the activity in each working area over the course of the lifetime of the site.
Figure 3.14 Example Phased rehabilitation plan for Lodge sand mining site

**Undisturbed Site**
The initial state of the site is undisturbed land, covered by the typical bush and scrub vegetation of the surrounding area. The maximum extent of working has been defined and the site access track laid down.

**Phase 1**
The first phase of working is to extract sand from the northern boundary of the site, closest to the site access point. This will create the primary working area for the site that can be used in subsequent phases for equipment storage and site access.

**Phase 2**
The site will be worked from north-west to south-east. Having completed Phase 1 extraction, this area is converted to a site working area and Phase 2 extraction begun.

**Phase 3**
After the completion of extraction from Phase 2, this area can be prepared for restoration and rehabilitation. Whilst Phase 3 is being extracted, waste material can be used to assist with backfilling and landscaping of Phase 2 to support rehabilitation.
Phase 4
Active working proceeds to Phase 4, with an extended site working and access zone. Phase 2 restoration is complete, with active rehabilitation proceeding to the Phase 3 area not being used for access to Phase 4 working.
- Undisturbed area
- Active extraction area
- Site working & access
- Active rehabilitation area
- Restored area

Phase 5
Active working proceeds to Phase 5. Restoration of Phases 2 and 3 is complete, with active rehabilitation proceeding to the Phase 4 area not being used for access to Phase 5 working.
- Undisturbed area
- Active extraction area
- Site working & access
- Active rehabilitation area
- Restored area

Phase 6
Active working of the quarry is completed. Focus is now on site clean-up, starting with the Phase 5 area. Restoration of Phases 2, 3 and 4 is now completed.
- Undisturbed area
- Active extraction area
- Site working & access
- Active rehabilitation area
- Restored area

Phase 7
Restoration retreats back towards the site entrance. Having completed restoration of Phase 5, focus of clean-up and rehabilitation turns to the site working and access zones.
- Undisturbed area
- Active extraction area
- Site working & access
- Active rehabilitation area
- Restored area
Phase 8
Rehabilitation works are complete and the site is fully restored.

- Undisturbed area
- Active extraction area
- Site working & access
- Active rehabilitation area
- Restored area
### Table 3.1 Progressive working and rehabilitation of site phases

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<td>Phase 8</td>
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</table>
3.9 Aftercare

Restoration and revegetation may take several years to establish and there will be an ongoing need for aftercare of sites until rehabilitation is completed. Key aftercare activities should include:

- Inspection of the site to assess the health of vegetation and check for erosion, animal browsing, weeds, etc
- Carrying out additional restoration work where required to fully establish vegetation cover, such as applying additional fertiliser
- Repairing landforms where erosion has occurred and ensuring that effective drainage is maintained.

Site rehabilitation can be considered complete when the site is assessed as self-sustaining, stable, non-polluting and not affected by significant erosion. Additional conditions for the final landscaping and vegetation of the site could be specified – for example, the required density of vegetation (trees per hectare) or diversity of plant species.

In the climate of St Kitts and Nevis, vegetation will re-establish rapidly where there is sufficient topsoil available. A good example of this is the rapid recovery of vegetation at the former sand mining site at lower Wash Ghaut, where the extent of re-established vegetation can be seen in Figure 3.15.

Figure 3.15 Vegetation re-growth at Lower Wash Ghaut sand mining site
It should be noted, however, that uncontrolled vegetation regrowth can often allow invasive species to take hold. In order to avoid invasive species taking hold, a structured programme of specific planting should ideally be followed in order to deliberately create an environment that is in keeping with the natural species mix that would be expected.

**Alternative site uses**

As well as restoration to a natural/semi-natural state, rehabilitated quarry sites may also be suitable for consideration for other site uses – for example, residential or commercial development. These site uses are potentially feasible, but careful consideration should be given to geotechnical concerns, since the construction of buildings on former quarry workings can be at high risk of subsidence and landform movements. Where consideration is to be given to further development of quarry sites following the cessation of working, this ideally needs to be planned substantially in advance. Advance planning can then ensure that:

- Site access is appropriate for the intended final use of the site
- Access to utilities is appropriate for the final use of the site
- Geotechnical issues can be identified and addressed appropriately
4. Summary and conclusions

4.1 Overview

The purpose of this report has been to expand upon the environmental considerations set out in the Legislation and Policy report to provide description and examples of good practice in environmental management. The key considerations identified in that report are summarised in Figure 4.1.

Figure 4.1 Key considerations for the environmental management of quarrying and mining sites

<table>
<thead>
<tr>
<th>Definition of site and activity</th>
<th>Environmental Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>For all quarrying/mining activities it is important that there is a clear definition of the site and activity proposed, as required by the National Conservation and Environmental Protection Act.</td>
<td>Alongside the definition of site and activity, environmental considerations should also be included in permissions for quarrying and mining activities. These would normally be included within the Environmental Impact Assessment for the site, as required under the Development Control and Planning Act (St Kitts) or the Physical Development Control Ordinance (Nevis).</td>
</tr>
<tr>
<td>• Definition of proposed extraction area</td>
<td>• Site runoff and surface drainage management</td>
</tr>
<tr>
<td>• Duration of extraction activities</td>
<td>• Groundwater protection</td>
</tr>
<tr>
<td>• Volume to be extracted</td>
<td>• Waste management</td>
</tr>
<tr>
<td>• Depth of working</td>
<td>• Dust suppression</td>
</tr>
<tr>
<td>• Phased working</td>
<td>• Noise</td>
</tr>
<tr>
<td>• Topsoil and subsoil preservation</td>
<td>• Landscaping, restoration and aftercare</td>
</tr>
<tr>
<td>• Geotechnical considerations and facing angles</td>
<td></td>
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</tbody>
</table>

This report has elaborated on each of these considerations, illustrating good practice through examples based on sites across St Kitts and Nevis. The headline good practice recommendations from the report are summarised in the sections below.

4.2 Definition of site and activity

Good practice for environmental management starts from the initial planning of a site – ensuring that there is a clear definition of the site and activity proposed (as required by the National Conservation and Environmental Protection Act) ensures environmental issues can be considered in advance and appropriate mitigation measures deployed to avoid and minimise impacts.

The key good practice recommendations with respect to the definition of site and activity are summarised in Table 4.1.

Table 4.1 Site definition - key recommendations

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Key recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of proposed extraction area</td>
<td>• Spatial limits of extraction should be clearly defined and mapped</td>
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<tr>
<td></td>
<td>• Land ownership and extraction permissions should be clearly understood</td>
</tr>
<tr>
<td></td>
<td>• The definition of a site should give consideration to:</td>
</tr>
<tr>
<td></td>
<td>o Site selection with respect to nearby land uses</td>
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</tbody>
</table>
4.3 Environmental considerations

The existing legislative and policy landscape in St Kitts and Nevis contains structured, clear and strong provisions to manage the environmental impacts of the extraction of sand, gravel and stone. In particular, there are strong regulatory and policy processes in place for development control, including EIA requirements that are explicitly linked to quarrying/mining as an activity requiring EIA. This gives good provision for the government to impose suitable controls when considering new quarrying activity. The environmental considerations presented in this report provide additional detail on good practice measures, summarised in Table 4.2.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Key recommendations</th>
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<tbody>
<tr>
<td>Duration of extraction activities</td>
<td>• Duration of activity should be specified to allow a clear control point – a time by which activities must cease, or, if workable deposits remain, for a new permission to continue operation to be sought</td>
</tr>
<tr>
<td>Volume to be extracted</td>
<td>• The volume to be extracted should be defined as part of the initial permitting of a site, appropriate to the area and duration of extraction activities</td>
</tr>
<tr>
<td>Depth of working</td>
<td>• Depth of extraction should also be clearly defined alongside the volume to be extracted – this is particularly important in protecting groundwater from intrusion from workings</td>
</tr>
</tbody>
</table>
| Phased working                             | • A phased working plan should be defined as part of the extraction permission to show how the site will be worked over time. A phased working plan will set out:  
  o How deposits will be worked in a systematic manner, generally across or downslope such that worked out areas can be rehabilitated without further disturbance  
  o Development of a systematic plan of benches or bays to be worked and rehabilitated in succession  
  o Minimising the disturbed area at any one time, ensuring that vegetation is preserved and not needlessly destroyed by brief activities  
  o Planning for the storage of waste rock and overburden in formally designed stockpiles and a plan to reuse this material in successive rehabilitation of worked areas |
| Topsoil and subsoil preservation            | • Quarrying and sand mining activities will normally require the removal of topsoil and subsoil, and potentially additional overburden. This material is a valuable resource for the successful rehabilitation of sites after use and, as such, should be retained. Ideally, this should happen as part of a phased rehabilitation plan, thus avoiding the long-term stockpiling of material. |
| Geotechnical considerations and facing angles | • Quarries should be carefully designed such that the landform poses no slope failure, slumping or collapse risk to employees or the public. Natural instability should be minimised by setting a face orientation which optimises stability while minimizing the induced stability by adopting an appropriate method of excavation. |
### Table 4.2  Site definition - key recommendations

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Key recommendations</th>
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</thead>
</table>
| Site runoff and surface drainage management | • Quarrying and mining activities have significant potential to lead to problems with respect to surface runoff and land drainage where not managed effectively. Effective management of surface water issues should include:  
  o Locating activity away from ghauts to ensure they are not removed, damaged of polluted  
  o Minimising disturbed areas to reduce the potential for erosion and entrainment of sediment  
  o Implementing drainage measures to control and route runoff  
  o Controlling sediment through the use of settlement ponds, filter strips or constructed wetlands to trap sediment before it is discharged from site  
  o Locating stockpiles well away from drainage pathways, channels and drains  
  o Preventing pollution by ensuring sources of potential contamination are located on impermeable surfaces and surrounded by bunds |
| Groundwater protection                      | • The most effective means of ensuring that quarrying or mining activity does not impact groundwater is to avoid active working in deposits above or containing groundwater aquifers – although it is unlikely that this scenario would arise in St Kitts and Nevis because of the existing protection given to aquifers critical to water supply (e.g. the Basseterre Valley Aquifer)  
  • Primary mechanisms to avoid impacts on groundwater are:  
    o Managing spills and storage of potentially polluting materials to minimise the risk of point source pollution  
    o Avoiding excavation below the water table |
| Waste management                            | • Quarrying and mining activities have the potential to create significant quantities of ‘waste’ material as a result of extraction and processing. All activities should have a plan in place to minimise, treat, recover and dispose of extractive waste. Through effective planning, waste materials can often be minimised, stored on site and then re-used in the restoration or rehabilitation of the site at the end of its working life.  
  • Waste management plans should be developed to outline the approach to be taken to minimise, treat, recover and dispose of all extractive waste.  
  • Management of tailings is not a particular issue for sites in St Kitts and Nevis, but particular attention should be given to the storage of fine materials recovered from settlement ponds – if left in unmanaged stockpiles, fine material can very easily be eroded and transported by rainfall and run off from the quarry site. |
| Dust suppression                             | • Dust can pose an environmental challenge both by impacting the health of workers and impacting the wider environment in the vicinity of the site.  
  • The primary means of reducing the environmental impacts of dust is to apply techniques to suppress the generation of dust through techniques such as spraying and watering, use of binding agents applied to stockpiles, covering truck loads during transportation and consideration of prevailing wind direction and use of vegetation as wind breaks to minimise dust mobilisation  
  • Appropriate PPE should be provided to site workers, including respirators/masks, coveralls and gloves. |
| Noise                                       | • Quarrying and mining activities can give rise to considerable noise and this will be a major consideration where working is proposed close to dwellings or other noise-sensitive properties. Good practice measures to minimise the disturbance impacts of noise from quarrying and mining activities include:  
  o Appropriate buffer distances between quarry sites and residential sites  
  o Consideration of prevailing wind directions |
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Key recommendations</th>
</tr>
</thead>
</table>
|                                            | • Siting noise equipment to allow for mitigation of noise impacts  
|                                            | • Restricting hours of operation to minimise impacts on others  
|                                            | • Use of barriers or screens to shield noisy machinery and minimise noise disturbance  
|                                            | • PPE should be provided to workers and occupational health and safety systems should be in place to monitor and control employee exposure to noise and vibration. |
|                                            | • Once extraction activities have ceased, quarrying/mining sites should be restored as close as possible to a natural state. The requirements for restoration should be set out in the initial permissions for a site to be worked and should cover:  
|                                            |   o Site clean-up – ensuring that the site is properly decommissioned, including removal of machinery, infrastructure and waste materials, breakup or burial of concrete slabs, loose rock, etc and rehabilitation of hardstanding areas, surplus roads and tracks, etc.  
|                                            |   o Reshaping the site topography to blend into the surrounding landscape in a manner appropriate to the final intended use of the site, including regarding or levelling of residual stockpiles, reducing the slope of erodible surfaces and regarding overburden to push material into hollows and level the site  
|                                            |   o Establishing a self-sustaining vegetation cover that protects the site and is consistent with the final land use, with preventative steps taken to minimise disturbance and allow vegetation to be established as rapidly as possible.  
|                                            | • The most effective approach to minimise environmental impacts from quarrying/mining activity is to work and restore sites progressively – as each area of the site is worked for extraction, it should be restored whilst new areas of the site are worked. This approach minimises the total disturbed areas and allows overburden and topsoil to immediately contribute to restoration rather than need to be stored. Progressive rehabilitation should be included as part of a progressive working plan for the site.  |