

## REDEVELOPMENT OF MINING AREA

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**Abstract:** *The mining industry can have a lot of consequences for mining regions and the surrounding landscape. Vegetation and wildlife as well as human life can be negatively impacted when mining production is abandoned. Reclamation old mining areas can be an extremely difficult job. With appropriate plans and tools, abandoned mining pits can be turned from degraded landscapes into prosperous man-made tourism attraction. This is what has been done in some mines, where they are provided analyses and strategies for creating and recreating a pit lake. Decision making for reclamation must take into account government policies (local, regional and national), financial investment, site factors, agricultural status, public requirement and availability of restoration techniques.*

**Key words:** *open pit mine, recultivation, lake, tourism, recreation, degradation*

### Introduction

Tuzla canton is characterized by enormous industrial mining zones, where lignite and brown coal has been mined and used for electricity generation. Mining activities are still going on and one large power station continues to produce electricity. A number of old pits left behind by the mining process have already been transformed into a new landscape, creating a massive new lake. As result of mining processes, the ecological system is un-balanced, there are damages of the land or even total devastation. The largest devastation of land is a result of erosion, fires on open spaces, contamination of the soil from industrial waste, mining digs of stone, constructive material, sand and other building materials (Bowman and Baker 1998; Brown and Caldwell 2006; Asarco-mission complex 2008).

### Process of reclamation

Reclamation is very significant aspect of the vision of the mining industry. It is one of components of the life-cycle of a mine. Open pit mining requires extensive reclamation strategies to be integrated with exploitation of ore and the handling with overburden, and all strategy of the development of the mine (Bowman and Baker 1998; Brown and Caldwell, 2006; Surface Mining and Reclamation Division, 2011).

Traditional reclamation is the “end” mine, and is usually directed at stabilizing slopes and reseeding damaged area. A few researches have been conducted on alternative methods of reclamation with respect to different conditions and visions of the mine site. New approaches in reclamation may offer mining developments the opportunity to integrate disturbed landscapes into complex of well developed community or ecosystem (Bowman and Baker 1998; Gammons et al. 2009; Brown and Caldwell, 2006; Asarco-mission complex 2008; Ze-wei 2000).

There are three categories of reclamation levels: restoration, reclamation and rehabilitation. Restoration implies restoring affected landscapes to the conditions that existed prior to the disturbance. This includes recreating original topography and re-establishing the previous land condition. Reclamation implies an approximation of previous conditions or where a different condition is established that is appropriate to surrounding land uses and conditions. Rehabilitation predicts to the return of a disturbed site to a stable and permanent use (Bowman and Baker 1998; Asarco-mission complex 2008; Villain 2011).

Main goals of reclamation include (Gammons et al. 2009; Brown and Caldwell, 2003):

- ∞ Providing slope stability and they fitting with the surrounding undisturbed landscape;
- ∞ The establishment of a post-mining land use;
- ∞ The remaking of the damaged land to topography that contributes to the entire area;
- ∞ To set a state of reclamation that is suited for different uses.

The practice of reclamation is limited by numerous of factors, such as changes in the ore bodies, climate, and environmental facts. Scientific research takes a significant role in defining what may or may not be applied to a disturbed mining area. The data for such research are established in the design standards and the standards described in legislative documents. Integrated resources management involves local community and people in the decision making process. Their participation is a key element in attaining sustainability in the mining industry and must play a role in the development of a description of the post mine landscape (Villain 2011; Brown and Caldwell; 2000; Bowman and Baker D. 1998). Regional planning and reclamation areas affected by mining operations should comply with the spatial planning of local governments and regions.

### **Reclamation of open pit mine by forming lake**

On completing of mining, final cut end-pits are created where there is an insufficient amount of overburden material available to

reclaim the natural profile of the landscape. One possible reclamation endpoint could be the creation of end-pit lakes. Pit lakes are a key component of mine closure and aquatic reclamation for many existing and planned open pit mines<sup>1</sup>. The construction of end-pit lakes is completed by replacing and reshaping the overburden removed during mining allowing the end-pits to fill with water from constructed surface inflows, surface runoff, and/or groundwater intrusion. Their shape is function of original mining techniques. End pit lakes created from dragline operations tend to produce long and narrow lakes that are asymmetrical about long axis of the lake. End pit lakes created from truck and shovel operations tend to be rounder, deeper, and have consistently steep walls at one end of the lake (Coal valley resources inc. 2011; Gammons et al. 2009).

Pit lakes are formed by water filling the open pit left upon the completion of mining operations. These pits can be filled by artificially flooding or allowing the pits to fill naturally through hydrological processes such as precipitation or ground water infiltration<sup>2</sup>. Pit lake reclamation options have been considered during all activities at open pit mine. These activities have included consideration of groundwater quality and pit backfilling. An important detail in pit lake partial backfilling and reclamation understands the source of pit lake water. The water in pits may be a result of surface water, subsurface water, or a combination of both. Final reclamation of pits must take in account topography of the pit area so that surface water accumulation on top of the reclaimed pit is minimizes. Subsurface water sources that may enter a pit on different ways like: seeps, springs, localized water tables or groundwater. An understanding of the source of this water is important to predict water rebound in the reclaimed pit and also to predict groundwater outflow (Gammons et al. 2009; Vandenberg et al.; Ze-wei et al. 20003).

Development of conceptual pit lake model is a key component of the preliminary design phase to ensure that an appropriate set of field data is collected. Based on the physical dimensions, geology and catchment area of the open pit, inflow rates and chemistries may be characterized for natural and reclaimed areas within the catchment area (Gammons et al. 2009; Vandenberg et al.). These lakes serve multiple functions, including uses for wildlife habitat, boating, fishing, water supply and aesthetic value. Their potential for use depends on, water

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1 . Vandenberg et al.

2 . Gammons et al.

quality consideration, and ecological functions of mine pit lakes (Gammons et al. 2009; Ze-wei et al. 2000).

### **Example of end-pit lakes in Bosnia and Herzegovina**

Due to many years of coal mining on open pit mines of brown coal mine Banovici, was formed a lot of degraded area, whose surface is currently at around 1,650 ha. In the next 10 years is projected rise of degraded areas to about 2,100 ha.



Figure 1. Open pit mine ‘Turija’



Figure 2. Lake at ex pit mine SICKI Brod Mine Kreka Tuzla



Figure 3. Lake at ex pit mine Visca-Djurdjevik



Figure 4. Ramicko lake at pit mine Banovici



Figure 5. Bistarac lake at pit mine Lukavac

Open Cast Basigovci was active during the period of the 1981st up in 1985. After closing the open pit was made only a partial reclamation of the technical side of the mine, while the biological reclamation occurred spontaneously under the influence of nature in which they are naturally established plant species inflicting biological recultivation. Community activities, initiated an intensive biological reclamation of part of the open pit and landscaping area around the artificial lake surface mine. Arranged access to the lake surface mining RMU "Djurdjevik" in the settlement Basigovci lake has become a summer attraction for hikers and swimmers, and out of summer season it is quiet place for fishermen.



Figure 6. Pit mine Basigovci after biological reclamation



Figure 7. „Rajsko jezero“ lake at Basigovci pit mine



Figure 8. Regulative plan of Basigovci lake

The plan provides a water surface of the lake of 74 km<sup>2</sup>, arranging the lake shore in the form of beaches, construction of indoor and outdoor swimming pools, fountains, 24 houses in ethnic style, playgrounds, swimming pools for children, crafts and business center, a horse farm, areas for orchards and berries, stadium, castle and old town imitation "Jasicak" football stadium, fruit processing plants and other facilities. Regulatory Plan creates significant opportunities for business development in the field of agriculture, horticulture, animal husbandry, industry, trade, catering, old crafts, recreation, sports, entertainment and tourism.

Recultivation open pit, creating terrace areas, planting and afforestation will provide a new atmosphere within a natural entity. Green areas will be maintained as parks, enriched with indigenous tree species, that are natural habitat for local birds and other animal species.



Figure 9. Bistarac lake

There are examples the various recreational opportunities provided by pit lakes, with sport fishing opportunities being one of the most prevalent. Sport fishing is often a major contributor to the tourism economy of an area, therefore pit lakes that provide fishing opportunities can also contribute to the local economy (Gammons et al. 2009).



Figure 10. Fishing at Ramicko lake



Figure 11. Fishing at Sicki Brod lake



Given favorable water quality conditions, wildlife may also be frequent visitors to, or common inhabitants of, pit lakes, and in such cases these water bodies could provide exceptional wildlife viewing opportunities (Gammons et al. 2009).



Figure 12. Development of wildlife at Ramicko lake

Reclamation is natural end of each mine. It is our obligation and our duty that abandoned mine leaves behind us in the best possible condition so that it fit into the natural environment that surrounds it.



Figure 13. Development of wildlife at Bistarac lake



Figure 14. Boating at Sicki Brod lake



Figure 15 Diving at Bistarac lake

## Conclusion

When working on the reclamation of mining area, should distinguish the following stages:

- ∞ Preparatory,
- ∞ Basic,
- ∞ Special.

Reclamation with artificial lakes is the most practical, because of various economic, natural and other benefits:

- ∞ The development of wildlife,
- ∞ The development of tourism,
- ∞ Possibilities of build power plant,
- ∞ Irrigation, etc.

It is well known that rational decision-making and design optimization are extremely important in land reclamation. Decision making for reclamation must take into account government policies (local, regional and national), financial investment, site factors, agricultural status, public requirement and availability of restoration techniques. Problems do occur where this integrated view is not taken. Ecological restoration should include: legislation systems, ecological risk evaluation, ecological assessment, ecological planning, financial investment and benefit distribution, clean production techniques, resource regeneration and restoration and rebuilding eco-systems on mine waste land (Brown and Caldwell, 2000). Possible beneficial end uses for mining pit lakes are: permanent storage of mine waste, water supply for industry or agriculture, aquaculture. Functional habitat for aquatic life, recreation and tourism, metal recovery, scientific study (Gammons et al. 2009). As can be seen, there are some examples of mining pit lakes that were flooded many years ago and now have high recreational and ecological value.

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