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## 8. Indirect Injuries

### 8.1 Introduction

Section 107(f)(1) of CERCLA provides broad authority to natural resource trustees to recover damages to restore, replace, or acquire the equivalent of natural resources in the case of injury to, destruction of, or loss of natural resources [42 U.S.C. 9607(f)(1)]. The DOI regulations at 43 C.F.R. Part 11 elaborate on what damages may be recovered, including indirect injuries to natural resources.

43 C.F.R. § 11.15(a)(1) states that trustees may recover damages resulting from natural resource injuries that are reasonably unavoidable as a result of response actions taken or anticipated. Furthermore, 43 C.F.R. § 11.14(e) defines “baseline” as the condition or conditions that would have existed at the assessment area had the release of the hazardous substance under investigation not occurred. The absence of responsible parties’ actions, and not simply the absence of a particular chemical, defines baseline. Therefore, when a responsible party’s releases require response actions or changes in resource management that cause injuries, natural resource trustees may recover damages for those injuries. These injuries that result from response actions are referred to as an indirect injuries, and they are the subject of this chapter.

This approach is consistent with the requirements for quantifying injuries and damages under the DOI regulations. For instance, 43 C.F.R. § 11.72(b)(1) states that baseline data should reflect conditions that would have been expected at the assessment area had the release of hazardous substances in question not occurred, taking into account both natural processes and those that are the result of human activities. Further, 43 C.F.R. § 11.82(b)(1)(i) states that restoration or rehabilitation actions are in addition to response actions completed or anticipated pursuant to the National Contingency Plan. In addition, 43 C.F.R. § 11.82(d) specifies that the results of any actual or planned response actions, and the potential for additional injury from such actions, including long-term and indirect impacts, are factors to consider when selecting a restoration alternative. Finally, 43 C.F.R. § 11.84(c)(2) states that damages are the residual to be determined by incorporating the effects, or anticipated effects, of any response actions.

Therefore, the Trustees include an analysis of injuries that may result from response actions necessary to address hazardous substance releases by responsible parties. Section 8.2 outlines the trustees’ approach. Then, Sections 8.3 through 8.8 describe potential indirect injuries that may result from a variety of potentially necessary response actions. Finally, Section 8.9 presents the Trustees’ conclusions about indirect injuries.

## 8.2 Stage I Assessment Approach

The nature and extent of indirect injuries that result from response actions to address PCB contamination at the site vary depending on the type of response actions that will be selected and implemented. At this time, the RI/FS for the site is ongoing and the response actions to address PCB contamination have not yet been selected, so the indirect injuries that may result from response actions cannot yet be identified. However, a document prepared by the PRPs (Blasland, Bouck & Lee, 2000a) provides some insight on the types of response actions that are likely to be considered during the RI/FS process. Table 8.1 lists the kinds of remedial options that may be implemented at the site, based on the options listed in the PRP document. This chapter presents a discussion of the possible nature of indirect injuries that may be associated with each of the potential response actions. As more becomes known regarding the probable response actions that will be implemented at the site, the Trustees will continue to evaluate the indirect injuries that will result from the actions.

**Table 8.1. Remedial options for the Kalamazoo River**

Remedial option	Description	Chapter section
No further action	No further remedial activities to address PCB contamination	8.3
Access/deed restrictions	Constraints such as fencing and signs to limit access to property, and restrictions on future river use	8.4
Bank stabilization	Placement of vegetation or riprap material along banks of exposed sediment areas	8.5
Pool elevation control	Maintenance of existing dams to minimize downstream transport of sediment	8.6
Sediment capping	Covering of instream sediments with materials such as clean sediment, sand, gravel, geotextiles, or other capping materials	8.7
Sediment removal and disposal	Removal of instream sediments using mechanical or hydraulic methods (may include temporary alteration of channel) and disposal in existing or newly constructed landfill	8.8

Source: Blasland, Bouck & Lee, 2000a; options extracted from Table 3.2.

## 8.3 No Further Action

The no further action option must be included in the analysis of remedial action alternatives. Under the no further action option, no additional measures would be conducted to address PCB contamination at the site. Therefore, future direct injuries from ongoing PCB contamination will be the greatest under this option. Furthermore, if no additional work to reconstruct and maintain

the existing dam sills at the former Plainwell, Otsego, and Trowbridge impoundments is conducted, the structures are likely to fail (Hanshue, 2002). If this happens, large quantities of the PCB contaminated sediments that have accumulated behind the structures would be released downstream, causing a substantial increase in the exposure of natural resources to PCBs. This would result in an even higher level of direct PCB injuries in the KRE.

If, however, the dam structures are kept in place as a means of containing the PCB contaminated sediment behind them, then indirect injuries will result from the river not being returned to a more natural, free-flowing state. These indirect injuries are discussed in Section 8.6.

## **8.4 Access/Deed Restrictions**

Access restrictions could be used to limit public entry into areas used for fishing, thereby limiting consumption of PCB contaminated fish from the river, and deed restrictions could be used to limit activities on private lands to reduce potential PCB exposure (Blasland, Bouck & Lee, 2000a). Such restrictions may result in decreases of human use services provided by the KRE. For example, recreational fishing in PCB contaminated areas provides some positive value to anglers, even though the value is less than the value without any PCB contamination (Breffle et al., 1999). Therefore, damages associated with reductions in human use services that result from future access or deed restrictions may be quantified by the Trustees if access or deed restrictions are part of the selected response action for the site.

## **8.5 Bank Stabilization**

Stabilizing the banks of the Kalamazoo River in former impoundment areas could be used to reduce bank erosion and the ongoing PCB load from the banks into the river (Blasland, Bouck & Lee, 2000a). However, bank stabilization can also lead to river channelization and prevent natural geomorphologic processes from operating, thereby causing indirect injuries. The engineering method selected for bank stabilization will affect the nature and level of indirect injury resulting from this alternative. Use of a technology such as riprap (Figure 8.1) or sheetpile (Figure 8.2) will essentially eliminate riparian and nearshore aquatic habitat, alter the hydrologic and temperature regimes of the river, and affect sediment transport processes. Additionally, this type of engineered shoreline may have effects on the human use of the river by altering the aesthetic qualities and/or public access. For example, although ease of access to the shoreline may be facilitated by bank stabilization, human use may be impacted because of the absence of natural vegetation and the variety of habitats that provide scenic value to the shoreline. It is also likely that the quality of birdwatching and fishing will be reduced due to a loss of shoreline vegetation and nearshore instream habitat types.



**Figure 8.1. Shoreline stabilized with riprap.**

Source: Wyoming Natural Resources Conservation Service, 2002.



**Figure 8.2. Sheetpile along the Kalamazoo River.**

Source: MDEQ, 1997c.

The key to functioning stream systems is their dynamic nature, both seasonally and spatially. Completion of the life cycle of many riverine species requires an array of different habitat types whose seasonal availability is determined by the flow regime. Because overall stream behavior is maintained in dynamic equilibrium, changes in one of several variables such as flow, velocity, or streambed substrate will result in compensating changes in the other variables. Channelization and armoring (rip-rapping) of a stream section will cause permanent changes, removing the dynamic nature of not only the altered section, but also affecting the adjoining stream sections further downstream than might initially be anticipated. Stream channelization often increases stream velocity, thereby increasing the erosive power of the stream. Durable protection or armoring is then required to ensure the stability of the engineered modification through all flow events. Over time, maintenance of such modifications may be significant, particularly as other instream structures, such as dams, are modified or removed. The construction phase of such instream modifications alone will cause significant disturbance that will likely increase runoff, sediment transport, and turbidity and reduce downstream water and habitat quality for aquatic life.

Therefore, the intended benefits of channelization and armoring can be accompanied by ecological losses resulting from increased stream velocities and reduced habitat diversity. Instream modifications of this type result in less habitat for organisms living both in or on stream sediments (macroinvertebrates) and for those living in the water (fish). Stream channelization can disrupt riffle and pool complexes needed at different times in the life cycle of certain aquatic organisms and can cause velocity or habitat fragmentation barriers to movement (Federal Interagency Stream Restoration Working Group, 1998). Habitat is lost when large woody debris and undercut banks are removed, as both frequently support a higher density of aquatic macroinvertebrates and provide important feeding, resting and cover areas for fish.

Losses in riparian vegetation are also inevitable with channelization and armoring of streambanks. Riparian vegetation is critically important in stabilizing streambanks, maintaining temperature stability (minimizing rise in summer and minimizing drop in winter), providing microhabitats important to aquatic and terrestrial life, and providing continuous habitat to connect populations of wildlife along the river corridor. Riparian vegetation also provides a source for continual inputs of woody debris and detritus which provide cover and nutritive inputs for sustaining productivity (i.e., food for the base of the aquatic food chain). Such habitat losses can occur through direct removals during construction/modification, or indirectly via increased velocities that flush materials down stream. The net result is reduced habitat, reduced diversity in habitat, and reduced productivity and diversity of aquatic life at all trophic levels from macroinvertebrates to fish.

## 8.6 Maintaining Dam Structures

Flow of the Kalamazoo River is controlled by a series of dams, some of which have had their superstructures removed to their sill levels (see Figure 1.1). The Plainwell, Otsego, and Trowbridge dams were constructed in the early 1900s for power generation, and have been out of service since 1965 (Blasland, Bouck & Lee, 2000b; Rheume et al., 2002). Since then, the dams have been removed to their sill levels and allowed to drain. Some sediment was transported downstream by the resulting increase in stream flow velocity, but a great deal of PCB contaminated sediment remains stored behind these dams. One potential remedial alternative is to maintain these dams at sill level to prevent further disturbances and downstream transport of deposited sediment (Blasland Bouck & Lee, 2000a). Complete reconstruction and perpetual maintenance of the structures would be required if maintaining these structures is included as part of a selected PCB remedy for the site.

Were it not for the PCBs released from PRP facilities into the KRE, the State of Michigan would already have removed the bases of the dams at the Plainwell, Otsego, and Trowbridge impoundments (Hanshue, 2002; Sygo, 2002). The MDNR purchased the dams and surrounding areas with the objective to improve the water quality of the Kalamazoo River, and intended to remove the dams to further this goal. However, the State has been unable to remove the dams because of the presence of PCB contaminated wastes behind these dams (Hanshue, 2002). The State has implemented interim measures to stabilize the dams, but does not believe that the dams can be repaired to keep them safely in place for the long term and would not support a remediation scenario that includes dam reconstruction (Hanshue, 2002; Sygo, 2002). Documentation of the State's intent to improve water flow characteristics of the Kalamazoo River goes back at least to 1981 (MDNR, 1981a).

The DOI NRDA regulations define baseline as "the conditions that would have existed at the assessment area had the . . . release of the hazardous substance under investigation not occurred" [43 C.F.R. §11.14(f)]. Therefore, baseline conditions in the KRE include the river with the dam structures removed or capable of being removed without regard to PCB contamination. Adverse impacts caused by the ongoing presence of the dam structures are indirect injuries that result from the PCB releases.

The structures also prevent natural geomorphologic processes from acting on the river, which in turn help establish and maintain fish and wildlife habitat along the river corridor. Finally, human use of the KRE is reduced due to restrictions on boating use because of the structures. The dam structures are impassable to boats or canoes in either direction, and therefore recreational boating use is impaired because of the dams. Overall, the presence of the dams also restricts the State in managing state fisheries and wildlife resources. Maintenance of unwanted and obsolete dams, which degrade the natural resources of the Kalamazoo River, is in direct opposition to the goals of the State (MDNR, 2002; Sygo, 2002). The dam structures have had and will continue to have

several adverse impacts on KRE natural resources. The structures prevent the natural movement of fish and other aquatic biota and can have long-term impacts on the fish assemblages in rivers (Quinn and Kwak, 2003). Additionally, the low velocity of water in impoundments is detrimental to mussels (Mulcrone and Mehne, 2001). In a survey conducted in 2000, Mulcrone and Mehne (2001) found reduced mussel populations in the former Otsego, former Trowbridge, Allegan City, and Lake Allegan impoundments. Catch-per-unit effort ratios in these impoundments were 2.8, 1.6, 0, and 0 mussels/person-hour, respectively. The catch-per-unit-effort in the former Plainwell impoundment was much higher (20.1 mussels/person-hour), and Mulcrone and Mehne (2001) concluded that the current was most likely sufficient to support mussels.

In summary, despite the intent of the State to remove the dam structures to enhance the resources and human uses of the KRE, their removal has been prevented because of the presence of the PCBs in the sediments behind the structures. Therefore, indirect injuries have already occurred. These indirect injuries include the loss of the ecological and human use services that would be present if the river were returned to a more natural, free-flowing state by removal of the dam structures. Indirect injuries associated with the dam structures will continue in perpetuity should the PCB cleanup action include a component that relies upon maintaining the dams as a means of containing PCB contaminated sediments.

### **8.7 Sediment Capping**

Capping of stream sediments may be used to isolate PCB contaminated sediments from the active river system (Blasland Bouck & Lee, 2001) (Figure 8.3). Engineering technologies can enhance this process by increasing the rate of sediment deposition or effectively sealing the sediments. Particle broadcasting introduces additional fine particles to the system to increase the deposition rate, while an engineered cap involves placing one or more layers of material such as sand, gravel or geotextiles over the sediment.

In the short to intermediate time frame, sediment capping in river systems such as the Kalamazoo River can cause impacts to the benthic invertebrate community, with potential implications for fish and associated recreational uses. Assuming that the cap material is eventually covered with natural river sediment, these effects will eventually subside. Therefore, some indirect injuries resulting from engineered sediment caps may be relatively short lived. However, some indirect impacts may last longer. For example, the construction of an in-situ cap may reduce the water depth in the river, and may physically restrict recreational navigation services (Wisconsin Department of Natural Resources, 2003).



**Figure 8.3. Cross section of sediment cap over contaminated sediment.** An orange worm living in the sediment is visible.

Source: U.S. EPA, 2001.

Concern also remains regarding the long-term effectiveness of caps at isolating sediment contaminants (Palermo et al., 1998). Cap integrity can be compromised by erosion or human activities. Contaminants may migrate up through the cap via advection, diffusion, or bioturbation. In addition, physical and hydraulic characteristics and the existing and future uses of the river will affect the effectiveness of the cap. Ideal locations for in-situ capping are stable sheltered areas with mild currents and either deep water or shallower water which is not exposed to erosion (Wisconsin Department of Natural Resources, 2003). The Kalamazoo River is a dynamic system with a braided channel, and changes in channel location and velocity could compromise the ability of a sediment cap to isolate PCBs in the long term. To the extent that engineered caps do not provide long-term effectiveness in reducing PCB exposure, these impacts would constitute residual direct injuries resulting from the PCBs themselves, rather than indirect injuries.

## 8.8 Sediment Removal and Disposal

Removal of PCB contaminated sediment from the site has also been proposed as a remedial alternative (Blasland, Bouck & Lee, 2000a). Excavation could be done with a mechanical dredge (Figure 8.4), which physically scoops the sediment from the bottom; a hydraulic dredge, which pumps the sediment in a slurry (Figure 8.5); or by controlling the flow of the river so that sediments can be excavated “in the dry.” The removal of PCB contaminated sediments from the KRE can be a very effective strategy for reducing the exposure of natural resources to PCBs, and thereby the ongoing direct injuries to resources. Nevertheless, sediment removal can cause indirect resource injuries that the Trustees may consider in future stages of the NRDA, if sediment removal is selected as a remedial option.



**Figure 8.4. Mechanical dredge removing sediment.**

Source: NOAA, 2000.

Sediment removal can cause substantial alterations to the river bottom habitat (Cushing, 1999) and associated impacts to benthic communities. For example, Mulcrone and Mehne (2001) reviewed the impacts of dredging activities on mussel populations in the Kalamazoo River. The catch-per-unit-effort at locations where sediment has been removed, the A-Site/Willow Blvd. location (4.5 mussels/person-hour) and the King Highway location (6.9 mussels/person-hour), was lower than the catch-per-unit-effort at a reference location in Battle Creek (10 mussels/person-hour). These results suggested that mussel populations were affected by dredging activity possibly via physical destruction or shifting of mussel beds.



**Figure 8.5. Suction-style hydraulic dredge.**

Source: Environment Canada, 1996.

As with sediment capping, these impacts should last only over short to intermediate time frames as the areas becomes covered with natural sediment and recolonized. Some development or road construction in the riparian corridor may also be required to provide access to the river, potentially reducing or eliminating areas of riparian habitat.

## **8.9 Conclusions**

The response agencies have not yet selected remedial actions to address PCB contamination in the Kalamazoo River. Remedial alternatives can cause indirect injuries to natural resources and the services they provide. The Trustees will consider the nature and extent of these indirect injuries as the remedial actions are selected for the site.