ISSUE BRIEF

December 2021

The Natural Resource Damage Assessment Process and Groundwater Management

Virgil Group

Acknowledgements

This issue brief was prepared by Policy Analyst Intern Wallis Cole and made possible with the help and collaboration of colleagues. Wallis would like to thank the experts she spoke with whose experience and insights provided a foundation for this report.

About Virgil Group

Virgil Group is a woman-owned nonpartisan startup dedicated to furthering impactful conservation and sustainable commerce by contributing to the development of new tools, policies, and cross-sector partnerships.
Visit virgilgroup.com to learn more about our services, mission and opportunities.

Executive Summary

Groundwater is a natural resource that is used to provide ecosystem services such as crop irrigation and drinking water. These groundwater sources can become contaminated and prevent this usage along with the economic benefits derived from groundwater. Contaminated groundwater also has the potential to affect other ecosystem aspects such as surface water and organisms. Once this resource becomes contaminated, remediation must be enacted in order to protect communities that rely on groundwater for drinking water and agricultural purposes as well as the associated natural resources.

Groundwater management and remediation at contaminated sites can be guided by the Natural Resource Damage Assessment (NRDA) process. The NRDA process is an environmental remediation procedure that restores ecosystems back to the conditions present at the site before a contamination incident occurs. The three phases of the process are enacted in order to determine the extent of injuries at a contaminated site as well as determine the monetary damages associated with those injuries. A restoration plan is then followed to acquire or restore natural resources. The Hanford Nuclear site and the Port Gardner Bay site in Washington state will be used as case studies in this brief. Each site contains contaminated groundwater resources that have the potential to affect communities and natural resources in their proximity. With the implementation of the NRDA process, the groundwater contamination at each of these sites can be remediated.

An extensive literature review and interviews with subject matter experts from governmental organizations have served to inform this report. The analysis of these resources has demonstrated that the management of groundwater is a pertinent issue that must be addressed. Improperly managed groundwater contamination can lead to the destruction of natural resources that are important not only to biological ecosystem factors, but also to human health and agro economies. The NRDA process serves to remediate groundwater resources at contaminated sites and the associated affected natural resources. This report includes adjustments that may be made towards the NRDA process in order to best manage groundwater.

The recommendations address:

- The engagement of potential trustees in the planning process;
- State-level policies that could be brought to bear in guiding the NRDA;
- Expediting remediation at sites with historically improper management;
- Use remediated sources benefit agro economies and increase potable water stores.

The management of contaminated groundwater can be guided by the NRDA process. Ensuring that this process is as effective as possible is essential in protecting this vital natural resource.

Forest stream


California State Department of Water Resources
Groundwater wells

Contents

1 GROUNDWATER DYNAMICS AND REMEDIATION

5 THE NATURAL RESOURCE DAMAGE ASSESSMENT PROCESS

7 WASHINGTON STATE CASE STUDIES

15 RECOMMENDATIONS

17 CONCLUSION

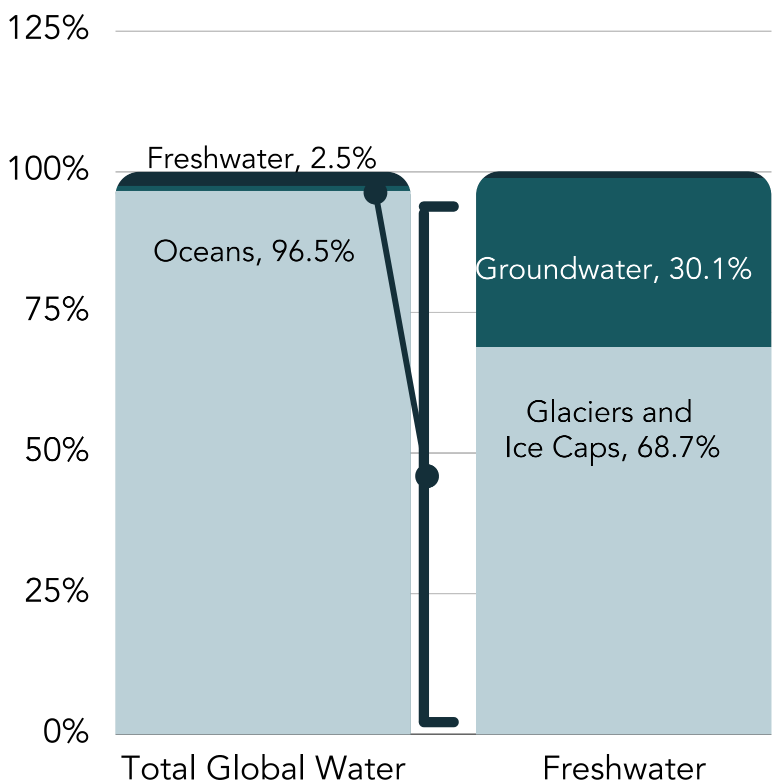

Groundwater monitoring well

Groundwater Dynamics

Of all of the water on Earth, only 2.5-3% of it is freshwater viable for human consumption. Earth's largest sources of freshwater are ice caps, glaciers, and permafrost. While some communities may derive their fresh water from these sources, other communities do not have access to these sources of freshwater. Therefore, groundwater, the second largest source of freshwater on Earth totalling at about 30.1%, acts as a solution to this issue (see figure 1). Groundwater is described as subsurface water contained within the soil matrix. It is a naturally formed water source that exists and moves between soil, gravel, and rock gaps. The groundwater formation process starts when surface water permeates into the soil via precipitation and snow melt, where it then travels into these gaps and further down to the water table (see figure 2).

The water table is simply the boundary between the zone of soil that is not saturated with water and the zone that is saturated. Once surface water reaches the water table, characteristics such as subsurface rock porosity and permeability influence the movement and storage of this water. Groundwater fills all other gaps in the soil matrix below the water table. However, if the rock is impermeable, groundwater will move toward larger surface water bodies or further into the Earth to reach permeable rock and be stored in aquifers. An aquifer is a holding place for groundwater. Aquifers are formed when groundwater surpasses the water table and saturates the gaps in the gravel, soil, and rock below. Groundwater from these aquifers can then be extracted manually or naturally for human consumption.

Figure 1

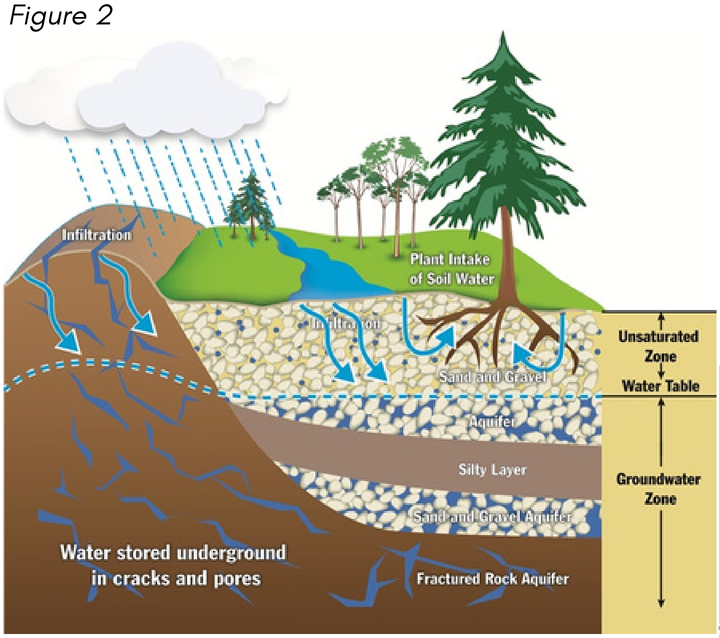


While groundwater moves toward the surface of the earth naturally via springs and discharge into streams, lakes, and wetlands, drilling directly into aquifers allows for rapid manual extraction to use the water for a variety of purposes. The main uses of groundwater in the United States are for drinking water and agriculture. Agriculture is an important component of the United States' economy, providing jobs and food security. Therefore, groundwater contributes economic value as a natural resource to the agriculture sector as well as to other sectors, including industry. Groundwater must be properly managed in order to ensure that it can continue to provide these services.

Groundwater contamination is not a rare phenomenon. Some common contaminants are oil, metals, and petroleum. While groundwater is not particularly susceptible to anthropogenic contamination, unprecedented sources of human pollutants, such as from the industrial and agriculture sectors, have tainted many aquifers in the US. For example, overpumping of groundwater for irrigation increases susceptibility to different contaminants, particularly fertilizers, and makes the flow of the groundwater at these sites more difficult to predict. The National Water-Quality Assessment, conducted by the United States Geological Survey between 1991 and 2010, showed that 1 in 5 wells from 9 regions with aquifers studied contained contaminants, either from human or geological processes, that were too high to be safe for human consumption. Once it is contaminated, groundwater becomes very expensive and complex to remediate.

Groundwater management poses some unique challenges. Other than the fact that this resource is underground, groundwater is difficult to manage because its discharge recharges, or replenishes, surface water bodies, such as lakes and rivers, causing groundwater contamination to influence other pollutants found in these water bodies too. Aquifers can border, overlap, and interconnect with one another. As a result, the contamination of one point source may then affect many other groundwater sources. This makes the resource especially difficult to remediate once contaminated.

Figure 2



Colorado State University.

Groundwater Infographic

Fast Facts

- 64% of the total groundwater withdrawals are attributed to crop irrigation.
- Groundwater is responsible for providing 51% of all drinking water in the country. Of that percentage, nearly all of the groundwater extracted for drinking water is used by rural populations.
- 99% of groundwater extraction used for drinking water is attributed to rural populations.

Groundwater Remediation

Various contamination incidents across the United States have the potential to affect important natural resources on local and national scales. Contamination of any natural resource has the potential to inflict critical injuries to natural resources and surrounding ecosystems. The contamination of groundwater not only affects that resource, but surface water, wildlife, and soil resources as well. Movement of contaminants, if not treated properly, has the potential to affect human populations, posing serious health risks for these communities. We will explore these consequences further by introducing the Natural Resource Damage Assessment (NRDA) and Restoration Program and analyzing two different sites in Washington state, the Hanford Nuclear Site and Port Gardner Bay. Both of these sites have contaminated groundwater that affects humans in proximity to the sites in addition to ecosystem components.

Remedial Action	Description	Pros	Cons
Pump and Treat (Active)	Groundwater is extracted, treated above ground, then pumped back to recharge the aquifer.	-Most common method of treating groundwater. -Can be used to remove a wide variety of contaminants post remediation of soil contamination.	-Very expensive. -Not always effective in removing the contaminants found in the water, as some of the chemicals may have bonded to soil particles around the aquifer.
Chemical/Biological (Active)	Different biological or chemical compounds are inserted into the contaminated soil or groundwater, creating a reaction with the contaminants to break them down.	-Cost effective. -Does not require the extraction of groundwater. -May also aid with soil remediation and can be used to clean up specific chemical compounds.	-Difficult to predict if the reaction will be successful due to the complex nature and extent of some contamination. -It could also introduce a whole new contaminant within the reaction process.
Air Sparging (Active)	Inserts non-contaminated air into the saturated zone where it then turns hydrocarbons from their dissolved phase within the water to vapor. The air with the vaporized hydrocarbons is then vented back out through the unsaturated zone.	-Less expensive than above ground treatments. -Easy to install and less expensive than pump and treat. -Treatment time is relatively short, totalling at 1 to 3 years for completion. -Installation of the treatment has minimal effects on other site operations.	-Not necessarily cost-effective. -Cannot be used for confined aquifers or on sites with stratified soils. -Technology for this method is relatively new which may lead to unforeseen effects. -May induce the movement of different constituents into other sites.

Permeable Reactive Barrier (Active)	Groundwater flows through these barriers and the toxins are filtered out in the process.	-Inexpensive and non-invasive to site operations. -Materials to make the barrier such as limestone, shale, and mulch can be cost effective. -No additional energy input is required.	-May take a longer amount of time to remediate contaminants if groundwater flow is slow or compounds are not dissolved in groundwater. -May not fully remediate the site, only make contaminants less harmful.
Monitored Natural Attenuation (Passive)	Relies on natural site processes to decrease contaminant levels and is closely monitored by sampling of the site's groundwater and soils.	-Inexpensive in comparison to other treatment options. -Does not require the introduction of new chemicals to groundwater sites. -Requires less labor and equipment for installation.	-Can be expensive over the long term. -Only works in certain conditions, specifically sites with already low contamination levels. -Takes a long time to fully remediate contamination, sometimes decades.
Plume/Source Containment (Passive)	Involved in the active process of pump and treat. Plume containment pushes the contaminated water from the plumes toward the wells that contaminated groundwater is extracted from for pump and treat.	-Prevents contaminants from reaching important groundwater extraction points, such as wells for drinking water and populated areas. -Must be applied when using pump and treat in order to contain the contamination source or "plume."	-Very expensive. -Only serves to contain plume/source of contamination. -Other methods of treatment, such as pump and treat, must be employed to decontaminate the site.

Table 1. Various remediation techniques exist with varying costs and effectiveness. In the United States, both active and passive remediation methods are used. Passive remediation relies on the natural movement of groundwater whereas active treatment utilizes corrective actions. Table 1 describes different techniques that are used to remediate groundwater, as well as their pros and cons and relative costs.

By Serikbaib from Getty Images

Groundwater spring

The Natural Resource Damage Assessment Process

The NRDA Restoration Program utilizes the legal foundation of three separate laws that allow the United States Department of the Interior and trustees to take the steps necessary to implement restorative actions and programs at various contaminated sites across the United States. The objective of the NRDA process is to "restore, replace, or acquire the equivalent of injured natural resources" and to provide compensation to those affected by the damages caused by the contamination. Contamination sites may be impacted by oil spills, hazardous waste, and vessel groundings.

The Federal Natural Resource Trustees for the NRDA Restoration Program include the Secretaries of Agriculture, Commerce, Defense, Energy, and Interior, amongst others, defined by the National Contingency Plan (NCP). The NCP dictates that these trustees shall act on behalf of the public in regard to the restoration of natural resources under their own respective managements on a national scale. The NCP also allows state governors to appoint State Trustees that act to protect natural resources within or belonging to the state's boundaries. Finally, the NCP includes tribal representation via the appointment of tribal chairmen as Tribal Trustees. Tribal Trustees act on behalf of natural resources belonging to the tribal body as well as resources set aside in trusts or belonging to tribal members. Other trustee bodies such as the EPA and NOAA have different roles in the NRDA process. The EPA is responsible for notification and coordination with the other trustees to initiate remediation projects at contaminated or threatened sites. They work in tandem with trustees to investigate and assess the damages at contaminated sites. They also notify the Federal Natural Resource Trustees of negotiations with Potentially Liable Parties and encourage participation given a threat to Trust Resources. The EPA is primarily responsible for oil spills and inland waters. NOAA utilizes their own program, the Damage Assessment, Remediation, and Restoration Program (DARRP) to carry out the steps of the NRDA process. The DARRP follows the same governing laws as the NRDA Restoration Program in addition to the National Marine Sanctuaries Amendments Act. NOAA is specifically a trustee for coastal and marine natural resources.

NRDA Governing Laws

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): Authorizes the the government or responsible parties to clean up contaminated sites. Allows trustees to assess damages to natural resources and use the damages for site restoration through replacement or acquisition of natural resources at the equivalent value pre-contamination.

Oil Pollution Act of 1990 (OPA): Trustees are granted the power to assess and recover damages at sites for which a vessel or oil spill is responsible for or threatens contamination upon United States waters, shorelines, or the exclusive zone. The OPA serves as an amendment to the CWA.

Clean Water Act (CWA): Natural resource trustees assess and recover damages resulting from oil spills into United States waters, shorelines, and the contiguous zone. CWA includes any resources outlined in the Outer Continental Shelf Lands Act or the Deepwater Port Act.

Trustees

Federal | State | Tribal | Other

The NRDA process requires assigning liability to the parties responsible for contamination. The trustee board is responsible for assessing the damages and presenting a claim to the Potentially Liable Persons (PLPs). Parameters of assigning liability to the PLPs may vary from site to site depending on the type of site properties, the extent of contamination, and restoration needed. Liable parties will sometimes refuse to pay for the damages of their contamination, in which case the board of trustees may sue the liable parties or, given the damage is an oil spill, file a claim to the Oil Spill Liability Trust Fund.

Different types of environmental assessments may be employed outside of or in conjunction with the NRDA process, but the NRDA is the only assessment that aims to restore a site completely back to pre-contamination conditions. While the other assessment methods are certainly helpful in the mitigation and remediation of contaminated sites, NRDA by far provides the most environmental benefits.

State-level authorities may also be enacted for site remediation. Some examples discussed later in this brief include the Washington State Model Toxics Control Act (MTCA) and the Puget Sound Initiative (Puget Sound Partnership).

To assess groundwater contamination at different sites, there are three different phases of the NRDA process: the pre-assessment phase, assessment phase, and post-assessment phase:

NRDA Phases

The **pre-assessment phase** assesses the injury that has occurred on the site. This includes reviewing materials already published on site properties, resource sampling, and mathematical modelling to determine the injuries caused by the contamination incident.	The **assessment phase** includes injury assessment, quantification and determination of damages. The injury assessment should include remedial actions and plans for implementing different clean up projects. It is made available for public comment and then a final assessment is issued. A consent decree between trustees and liable parties is also established.	The **post-assessment phase** produces a Report of Assessment to formally claim the damages associated with the site and their respective propogaters. A restoration plan is then prepared and implemented in compliance with the objectives outlined in the injury assessment.

Washington State Case Studies

Hanford Nuclear Site


City of Richland, WA

Richland Waterfront

Site History

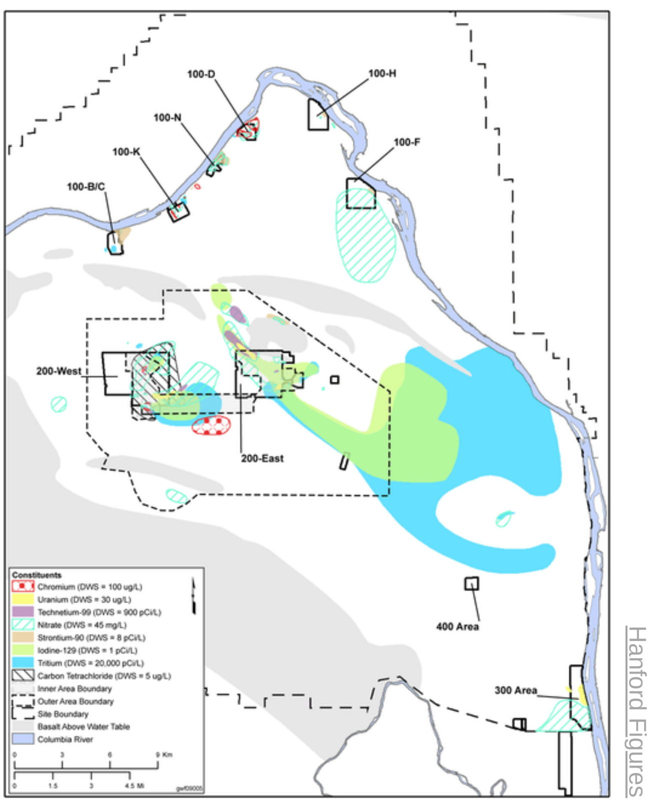
Hanford, Washington, is located in the Eastern region of Washington state in Benton County. Historically, the Hanford area has been home to several native tribes, known in the present day as the Cayuse Tribe, Confederated Tribes of the Umatilla Indian Reservation, Walla Walla people, Nez Perce Tribe, and Confederated Tribes and Bands of the Yakama Nation. By the mid-1800s, the Hanford area was colonized by European settlers who established the towns known as White Bluffs and Hanford. In 1943, the people of these towns and tribal nations were evacuated to allow for the construction of the Hanford Nuclear Site, a 586 square mile US Department of Energy-run plutonium extraction and refinery plant used to make nuclear weaponry for the United States in World War II, including for the Manhattan Project. The Hanford Nuclear site was operational from 1943 until 1990. There were a total of nine reactors and three reprocessing plants at the Hanford site. Most of the reactors were gradually shut down in this time frame, with the remaining N Reactor shutting down in 1987. The Plutonium Uranium and Extraction (PUREX) plant was ultimately shut down in 1990, nearly 20 years after the shut down of the other fuel reprocessing plants. The operation of the reactors and reprocessing plants inflicted serious damage on the natural resources available at the site.

Extent of Contamination

During the site's operational years, large volumes of chemical and radioactive waste were released into the environment via their discharge into the atmosphere, trenches, ponds, soil, groundwater, and the Columbia River. These chemicals were not properly remediated before release into the environment, creating a chemical soup of waste in the Hanford ecosystem.

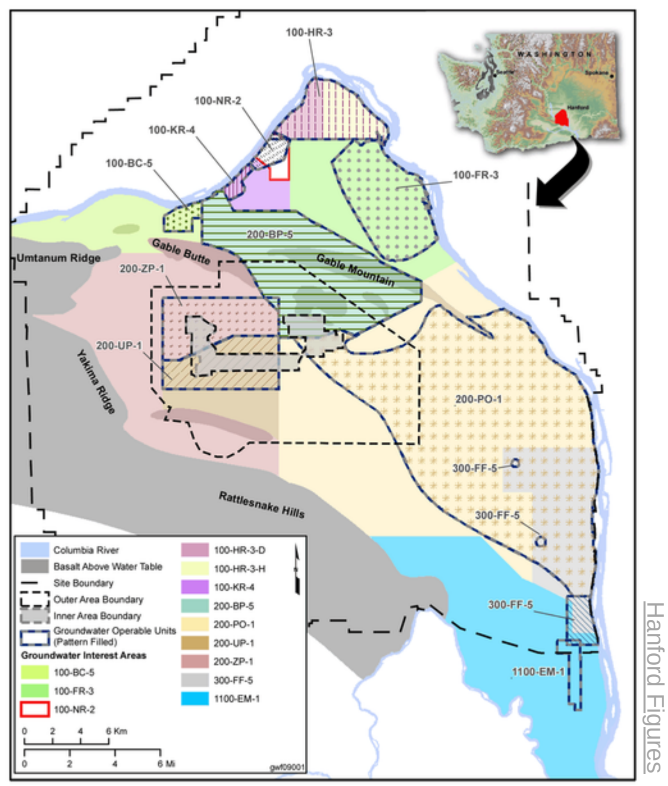
During times of increased demand, reprocessing of plutonium was shortened from a recommended 60 to 90 days of cooling time to 30 days of cooling time. This did not allow adequate time for short-lived radionuclides to break down, leading to further contamination. Continued improper disposal of these materials in underground tanks and surface-level storage areas resulted in leaks, exposing site workers and populations living downwind or downstream of the contaminants to small doses of radiation. This still occurs today at a much smaller scale but workers who are employed directly on the site are exposed to higher levels of radiation. This may lead to radiation sickness and in some cases cancer. In terms of specific groundwater contamination, the storage of irradiated uranium in concrete basins led to leaks of contaminated water from these basins into soil and groundwater. This is just one example of seepage of hazardous waste into groundwater at the site. Figure 3 demonstrates the various groundwater contamination plumes and the respective chemicals found in those plumes. The 200 area is one of the main areas of concern due to the proximity to the Columbia River, flow direction of groundwater, and extent of the plume (see figure 3).

Figure 3



Major Hanford Groundwater Containment Plumes

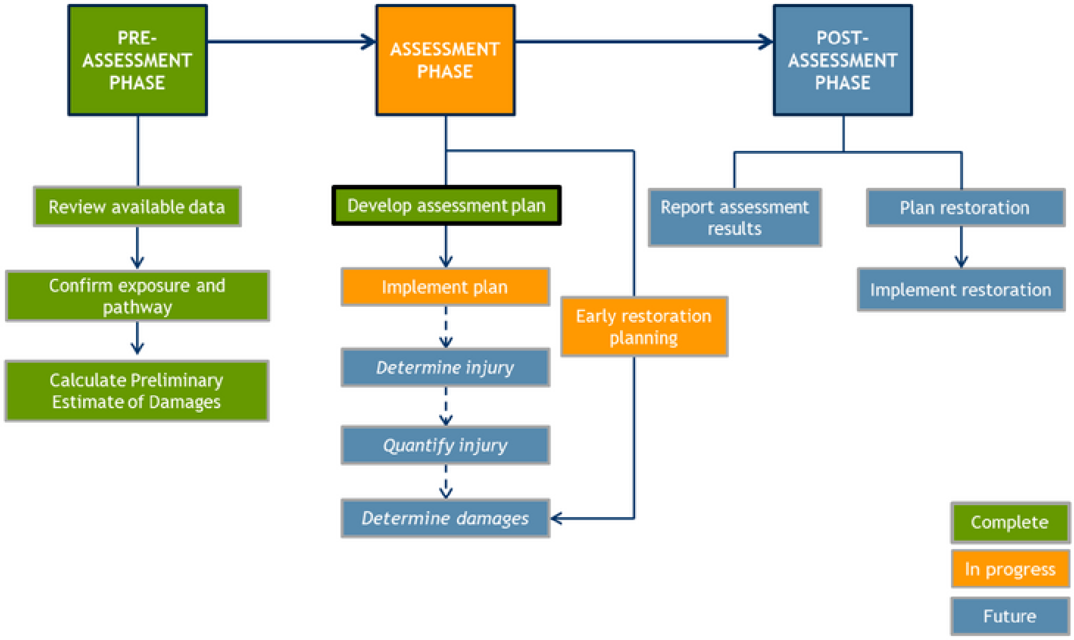
Figure 4



Hanford Groundwater OU Site Map

Injury Assessment

Figure 5



Hanford Natural Resource Damages Assessment Injury Assessment Plan

Hanford NRDA Status Flow Chart

The Washington State Department of Ecology, the Department of Energy, and EPA entered into the Tri-Party agreement in May of 1989. As per the agreement, four areas of the plant were put onto the National Priority List (NPL) based on a preliminary assessment conducted by the EPA: areas 100, 200, 300, and 1100 (see figure 4). A consent decree in 2010 under the Tri-Party agreement outlines the purposes of the agreement. Since the original consent decree, the pre-assessment phase and some of the assessment phase of the NRDA process have been completed with the inclusion of the Hanford trustees. The Major Groundwater Contaminant Plume map demonstrates the contaminated groundwater resources associated with each of the NPL sites, excluding the 1100 site which has since been removed from the NPL due to remediation efforts. The pre-assessment phase is outlined in the injury assessment plan, which details what still needs to be done to determine the extent of contamination and how to best remediate these contaminant plumes and associated natural resources. The most recent version of the injury assessment plan was released on January 31, 2013, and the current state of the assessment is discussed below.

The Hanford Nuclear Site has been in the assessment phase of the NRDA process since 2009 (see figure 5). This is unusually long for a NRDA assessment phase and is due in part to site complexity and minimal foundational knowledge upon which to structure a remediation plan. Given the volatile nature of the compounds present and the health risks they pose, it is essential to proceed carefully and cautiously through the NRDA process.

For groundwater resources, in order to fulfill existing knowledge gaps, trustees plan to develop a comprehensive database and comparison to injury threshold, a revision of contaminant plume mapping (see figure 3), and quantify groundwater contamination volume and time dimensions. A complete list of planned injury assessments for groundwater is detailed in the injury assessment plan draft. A final injury assessment plan has yet to be released.

After the implementation of the final injury assessment plan, the site injuries will be properly determined and quantified. Using that information, trustees will be able to assess monetary damages and compensation will be calculated. A Restoration Compensation and Determination Plan (RCDP) will be drafted and included in the Assessment Plan along with restoration alternatives determined from both injury and damage assessments. Although the site is only in the beginning of the assessment phase, Hanford trustees have begun remediation at some plant sites due to the time sensitive nature of the contamination. Pump and treat operations have commenced at some sites, including the 100-HR-3, 100-KR-4, and 100-NR-2 operable units. A Record of Decision issued by the Washington State Department of Ecology, the Department of Energy, and EPA in 2011 implemented a remedial action plan to commence groundwater remediation objectives at these operable units. Pump and treat has also commenced at plateau area operable units, otherwise known as the 200 area.

Next Steps

The Hanford Nuclear Site NRDA process exemplifies how different contaminants affect our natural resources, specifically groundwater, and our current and potential uses of those resources. Not only does contamination at Hanford affect the resources on that site, but the discharge of contaminated groundwater into the Columbia River, may also have consequences to surface water contaminant levels, aquatic species health, and other wildlife health. It is important to note that this surface water is not used for drinking. Contamination of groundwater at Hanford and at other sites also prevents the normal operation of ecosystem services that clean groundwater used for crop irrigation, municipalities, and homes. The report Potential Groundwater Availability at the Hanford Site written by Julie Padowski, Nigel Pickering, and Jonathan Yoder details this. There is a limitation of potential uses of groundwater, such as for drinking water and agriculture, once contamination occurs. Any level of contamination above drinking water standards outlined in state and federal policies renders a groundwater source invalid for the ecosystem services listed above. As can be seen in the municipalities in proximity to Hanford, many of these cities have had to eliminate the use of their groundwater wells due to high levels of contamination that create unpleasant odors, colors, and introduce harmful toxins in their water supply (Padowski et al.).

While this contamination may not be in direct correlation to Hanford site activities, many of the sources of contamination remain undisclosed. Moreover, many of the cities in proximity to Hanford Nuclear Site, such as Pasco, West Richland, and Richland derive their water sources from the Columbia River (Padowski et al.). Contamination from Hanford enters into the Columbia River, carrying contaminants downstream to these municipalities. The movement of contaminated groundwater from Hanford aquifers to the Hanford Reach is relatively slow, with the most mobile contaminants from the 200 East Area expecting to take a few decades to reach the Columbia River (Padowski et al.). However, the presence of these chemicals in drinking water could have adverse effects on human health such as cancers. The city of Richland has to artificially recharge their aquifers used for municipal water provision by pumping water from the Columbia River underground in order to create a buffer for the flow of contaminated groundwater from the Hanford site (Padowski et al.).

These municipalities could have used the groundwater at the Hanford given no contamination occurred. Should proper permitting and operation costs align with their respective water provision needs, the surrounding cities could have withdrawn groundwater at Hanford. This specifically applies to West Richland, which largely depends on Richland for their water supply. Projections for water use in these cities show increased demand for water coupled with decreasing water supplies. Hanford could have filled this demand prior to contamination.

Port Gardner Bay Site

Site History

The Port Gardner Bay site contains the lower Snohomish River, Everett Waterfront, East Waterway, and a portion of Possession Sound in proximity to the City of Everett, WA. The areas currently designated for remediation are much smaller in size than the Hanford nuclear site. These areas serve as waterways for commercial shipping and as wastewater outfalls from public and private sectors. The contamination of Port Gardner dates to the early 1900s, with the release of permitted and non permitted industrial waste discharges into the Bay, spillage during cargo transfers and refueling, contaminated runoff from waste produced at upland industrial facilities, and discharge of contaminated groundwater. Other uses of the waterway included lumber operations, pulp mills, and paper mills, which led to the discharge of waste from these operations. These industrial operations have created multiple point sources of contamination that have percolated into soils, groundwater, and sediment and have the potential to affect wildlife populations in the surrounding areas.

Using standard parameters to assign liability, the trustees have identified a few companies as PLPs, recently including the Port of Everett and U.S. Navy. Unlike Port Gardner, Hanford did not need to identify any PLPs because the Hanford was a federal project.

Consent decrees have been published between the trustees versus the PLPs identified here. The consent decree files a formal complaint against these PLPs on the grounds that they have sufficient evidence to find them liable for the contamination of Port Gardner and to outline settlement shares. In order to push these PLPs to settle the damage claims earlier rather than later, the trustees have used a contaminant footprint approach as opposed to assigning each facility responsible for specific contaminants a certain percentage of liability. By doing this, the responsibility for contamination is placed on certain facilities, which allows the multiple parties associated with those facilities to deal with the allocation of liability amongst themselves. As of January 31, 2018, a $4 million dollar settlement was reached between Jeld Wen, Inc., Kimberly Clark Corp., Weyerhaeuser NR Company, and the trustees resolving claims made about the PLPs responsibility in contamination. The consent decree filed against the Port of Everett and the U.S. Navy is currently open for public comment and calls for compensation for the preferred alternative selected by the trustees.

Extent of Contamination

Due to the heavy industrial past of the Port Gardner site, the notable contaminants present in the soil and groundwater include petroleum, gasoline, diesel fuels, PCBs, wood waste, tree bark, saw dust, arsenic, copper, and dense non-aqueous phase liquids (DNAPL). Some petroleum is stored in above and below ground tanks, while many of the other contaminants have infiltrated into the soil matrix and groundwater stores. In the groundwater stores, the petroleum, also known as a light non-aqueous phase liquid (LNAPL), sits on top of the water because it is less dense. As a result, different strategies such as air sparging (table 1) and soil excavation may be employed for remediation as opposed to classic pump and treat. The geology of the site prevents effective pump and treat use, so soil agitation, excavation, air sparging, and monitored natural attenuation are some of the only usable remediation techniques.

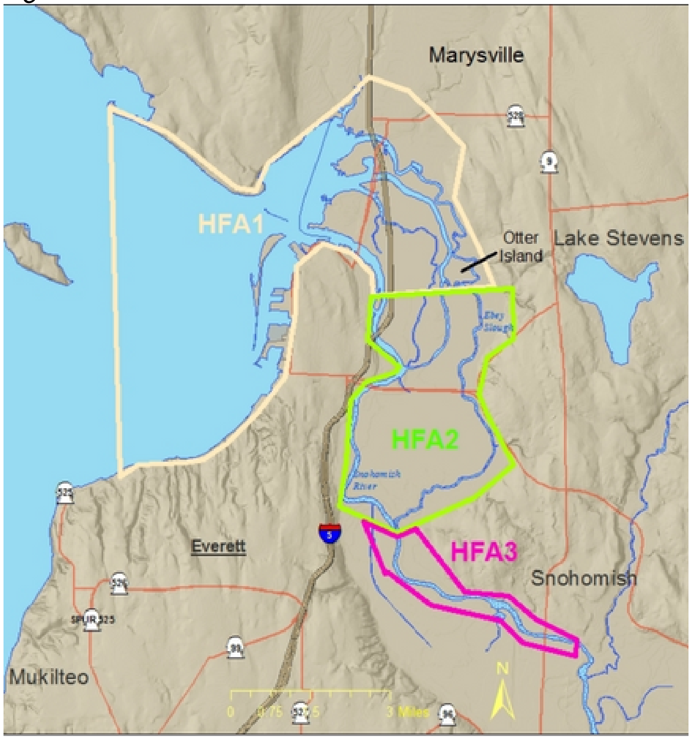
Contaminants such as arsenic and copper are much more difficult to remediate once they are dissolved in the groundwater supply. Actions that have been considered for these types of contaminants include impermeable barriers to prevent further movement of the contaminant plume along with permeable reactive barriers to remove these dissolved metals. Oftentimes soil excavation along with in situ soil agitation can help with remediation of these metals. DNAPLs involve heavy contaminants such as wood products that sit 50-60ft below the surface of the groundwater. Binding and capping of contaminants has been employed to remove them and stop their spread. In nearshore sites, monitoring of seeps from groundwater into surface water and shoreline ecosystems is being conducted to assess the quantity of contaminant release and prevent further harm to the organisms at these sites.

Contaminated groundwater seeps have the potential to harm tidal ecosystems, saltwater ecosystems, and wetland discharge ecosystems.

Injury Assessment

The Puget Sound Initiative has provided funding for cleanup of many Puget Sound sites, including Port Gardner, as of 2007. This initiative prioritizes baywide clean ups via the use of different environmental assessments. The Puget Sound Initiative, or Partnership, was finalized in 2007 by former Washington state governor Chris Gregoire. With this initiative, a panel of seven council members appointed by Gregoire will work in tandem to create legislation to protect the Puget Sound and its associated resources. The original initiative aimed to clean up the Puget Sound by 2020, but a new Puget Sound Action Agenda for 2022-2026 is currently being updated. The Port Gardner Bay trustees, NOAA, the U.S. Fish and Wildlife Service, the Washington Department of Ecology, Suquamish Tribe, and Tulalip Tribes, are conducting an NRDA injury assessment in concurrence with a Restoration Plan/Environmental Assessment (RP/EA). In compliance with NEPA, the RP/EA must be conducted to assess the potential impacts that different restoration projects might have on the quality of the human environment. The memorandum of agreement, signed in 2012, details that the trustees must work in collaboration to assess damages for the injuries present at the target areas, to plan, design, implement, maintain, and monitor the actions used to restore or replace injured resources, and to prosecute or settle with any liable parties or claims at the Port Gardner Area. The memorandum also details the 10 contaminated sites that will be assessed for remediation in compliance with the Washington State Model Toxics Control Act. The Model Toxics Control Act is Washington state's environmental clean up law that funds, remedies, and prevents the contamination of Washington state sites via the Hazardous Substance Tax. It is primarily enforced by the Toxics Cleanup Program and the standards for MTCA are set by Washington's Clean Up rule. As opposed to assessing and restoring each site individually, trustees will focus their efforts on three Habitat Focus Areas (HFA) containing these sites and their respective natural resources (see figure 6). These HFAs are determined by the types of injuries, habitat features, geographic boundaries, clustering of the 10 restoration sites, and other factors such as land use and wave energy present in the designated areas.

Figure 6



Port Gardner Bay Final Damage Assessment Restoration Plan and Environmental Assessment

Habitat Focus Areas at Port Gardner

The Port Gardner Bay site is currently in the Injury Assessment phase of the NRDA process. Review of existing literature and data on resources such as water, sediment, and tissue is being used to guide the injury assessment process. A final injury assessment plan has yet to be released for the NRDA, but a finalized version of a restoration plan associated with the RP/EA process has been published. This restoration plan will be used to guide the implementation of the finalized NRDA restoration actions. Restoration planning has also commenced as the trustees have determined that some restoration projects may be able to be employed in areas where risk of recontamination by surrounding sources is low, which has been concluded in the RP/EA conducted for NEPA. Some sites have begun the removal of contaminated soils whereas some sites have yet to have complete injury investigations and cleanup plans. As for the RP/EA process, the final restoration plan evaluates all proposed alternatives of action for site remediation in compliance with NEPA. This is to best determine what alternative will restore, replace, or acquire natural resources equivalent to those lost due to contamination. The alternative selected by the trustees is the Blue Heron Slough Restoration Project. This plan aims to both directly and indirectly benefit multiple natural resources damaged at Port Gardner Bay within a designated 354 acre span. Habitats that are targeted for restoration include off channel habitat, marsh habitat, mudflat habitat, and riparian habitat.

Next Steps

In order to fulfill the goals outlined in the restoration plan, trustees must come to settlements with all PLPs in order to compensate for the damages caused by contamination. With this funding from the PLPs, further injury assessment can occur on sites that do not have proper assessment or clean up plans. After this, the preferred alternative should be implemented as the plans for restoration under this alternative have been outlined with respect to NEPA and CERCLA parameters. Different restoration projects have already commenced on some sites, including Jeld-Wen and Kimberly-Clark Worldwide, such as habitat restoration and the plugging of pipes to prevent movement of groundwater to surface water respectively. In terms of groundwater, because pump and treat may not be employed, removal of contaminated soils and in situ agitation of soils have been used to prevent further contamination of groundwater resources. Once these soils are remediated, it is expected that with monitored natural attenuation that the groundwater sources will eventually decrease in contaminant levels. At sites with highly mobile groundwater and groundwater that has potential to affect municipal water, capping of plumes and impermeable barriers are used to prevent discharge of contaminated water.

Washington State Department of Ecology.

Everett, WA Waterfront

Recommendations

Based on the analysis conducted for both the Hanford and Port Gardner sites, recommendations can be made to ensure that the NRDA process and the management of groundwater is most effective.

Engage potential trustees in the planning process

One of the easiest ways to remedy environmental injury is to have a contingency plan if injury does occur. If a party is going to use a site for industrial purposes, a Natural Resource Trustee Board should be established before operations commence rather than during remediation. Different governmental organizations must be consulted for the green light on projects to occur, including a public comment period for federal projects. The requirement of a Natural Resource Trustee board on every federal project would streamline this process. There must be proper protocols put into place to ensure that the natural resources established by the trustees can be properly managed. Future potential trustees should be engaged in the development process so that an injury response plan can be prepared ahead of time.

More state-level policies could be brought to bear in guiding NRDA

As seen with Port Gardner, state level policies such as the Model Toxics Control Act and the Puget Sound Initiative were very helpful in providing funding and remediation guidelines for site cleanup. These policies take into account Washington state ecosystem factors, geology, and other state specific environmental characteristics. At Hanford and Port Gardner, because the Injury Assessment phase has not been completed, no Washington state policies have actively been employed to guide cleanup, but will be employed at Port Gardner. Furthermore, because Hanford is a federal facility, state policies may not necessarily be followed. However, stronger state policies should be put into place in order to guide the NRDA process so that remediation teams have stronger guidelines for remediation standards. This will also allow remediators to take into account Washington state specific objectives.

Expedite remediation at sites with historically improper management

While nuclear waste is not particularly more dangerous than other forms of industrial waste, the past management of radioactive materials has been insufficient. Radioactive waste has not been properly stored as it breaks down over thousands of years. Moreover, ingestion of nuclear waste particles can have adverse human health impacts. Fortunately, sufficient technology exists today to manage the storage of these materials. The same can be said about management of industrial waste. For this reason, remediation should be expedited to make up for past improper waste management and protect populations from health risks. At nuclear waste sites the NRDA process takes even longer than usual because of the human health concerns and the complex and cumbersome management process. For sites such as Hanford and Port Gardner, expediting remediation procedures before NRDA process completion should be considered in order to accommodate for the time sensitive nature of contaminant storage. There should be further exploration into legal remedies to address this.

Use remediated sources benefit agro economies and increase potable water stores

An Injury Assessment plan must be finalized with an assessment of the damages accrued at each site. With a complete remediation of the site given the completion of the NRDA process, there is potential for municipal and agricultural use given future need. However, the health risks posed with the act of decontaminating the site and the complex nature of the contamination may prevent this remediation from completion for decades to come.

Contaminated Groundwater

Conclusion

Groundwater management, specifically the management of contaminated groundwater sources, is a pressing issue that must be addressed via the implementation of preventative measures along with an effective NRDA process. Engaging natural resource trustees in project development, greater engagement with state level policies, and expediting the NRDA process in volatile cases will serve this objective.

The International Campaign to Abolish Nuclear Weapons

Citizens fighting for Hanford Cleanup