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Lessons Learned for Construction and Waste Water Management at Radioactive Waste Closure Site

K.D. Anderson, Esq., CHP
ECC
1746 Cole Blvd., Bldg. 21, Suite 350, Lakewood, Colorado
USA

ABSTRACT

Environmental remediation of three different radioactive waste closure sites each required exhaustive characterization and evaluation of sampling and analytical information in resolving regulatory and technical issues that impact cleanup activities. One of the many regulatory and technical issues shared by all three and impacting the cleanup activities is the compliant management and discharge of waste waters generated and resulting from the remediation activities. Multiple options were available for each closure site in resolving waste water management challenges depending upon the base regulatory framework defined for the cleanup or closure of the site. These options are typically regulated by the federal Clean Water Act (CWA), with exemptions available under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) or Memorandum of Understanding (MOU) between regulatory agencies. In general, all parties must demonstrate equivalent compliance when concerns related to the protection of the general public and the environment. As such, all options for management of waste water resulting from closure activities must demonstrate compliance to or equivalent actions under the CWA. The CWA provides for the National Pollution Discharge Elimination System (NPDES) that is typically maintained by individual states through permitting process to generators, public utilities, and more recently, construction sites. Of the three sites, different compliance strategies were employed for each. The approach for the Columbus Closure Project (CCP) was to initiate full scale compliance to the Ohio EPA General Construction Permit No. OHC000002. The CCP provided Notice of Intent (NOI) to the Ohio EPA to discharge under the general permit according to the regulator approved Storm Water Pollution Prevention Plan. For the second site, the Li Tungsten Superfund Site in Glen Cove, New York, the option was to manage and discharge waste water under a due diligence process to New York State General Permit No. GP-02-01. For the third site, the Middlesex Sampling Plant in Middlesex, New Jersey, the options was to manage and discharge waste water to the Publicly Owned Treatment Works (POTW). Each option has resulted in a safe, cost-effective, and compliant approach to managing discharging waste waters from the site closure activities.

INTRODUCTION

The itsy bitsy spider climbed up the water spout.
Down came the rain, and washed the spider out.
Out came the sun, and dried up all the rain
So the itsy bitsy spider climbed up the spout again.

[1] This popular nursery rhyme describes the adventures of a spider as it ascends, descends and reascends the downspout or "waterspout" of a gutter system. Fortunately for the spider, it would appear that his misadventures with storm water are easily addressed by the warm light of the sun. Unfortunately for the remainder of the Readers the management of the impact of storm water discharge is not so easily resolved.

NPDES and SW4s

The Clean Water Act's (CWA's) forms one of the cornerstones of current federal environmental protection. When first enacted in 1972, the primary focus of protection was point sources of effluent form factories and public sewage treatment plants. Such sources were initially identified and brought under control through the application of treatment methods and standards reflected in a permitting process. The National Pollution Discharge Elimination System (NPDES) provided the mechanism to initiate water quality standards applied to these point sources of discharge to navigable waters. Permits issued for point source discharge typically provide for engineered treatment processes, locations and effluent rates of discharge, and numeric treatment standards for listed pollutants. [2]

The CWA's MS4 provisions, 402(p)(3)(B, 33 U.S. C. 1342 (p)3)(B), does not, on its face, mandate that MS4 discharges receive treatment designed to meet water quality criteria or any other form of numeric effluent limitations. [3] Instead, the statute directs MS4 operators and users remove storm water pollutants to the maximum extent possible (MEP) using best management practices (BMPs) contained in NPDES permits. While not specifically defined in the statute, it is generally accepted that MEP involves the application of engineering methods and management practices that together are intended to limit pollution from storm water runoff as much as possible. [4]

Accepted understanding of the intent of the MS4 provision has none the less resulted in less than satisfactory performance against water quality goals. Storm water continues to contribute significant amounts of sediment and surface pollutants that have extremely harmful impact on water quality and supporting ecosystems. [5] As a result, states and non-governmental organizations (NGOs) are pressing for numeric effluent limits for MS4s to that storm water discharges will comply with state water quality standards. [6] Arguments for moving away from MEP through BMP are based on the residual authority contained in 33 U.S.C. 1342 (p)(3)(B)(iii), which states that MS4 discharges are subject to "such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." [4]. As such, individuals seeking discharge under the MS4 portions of NPDES permits may or are now facing far more stringent requirements reflected in numeric effluent limits.

Individual users or generators seeking to discharge under an existing NPDES permit must seek approval from the Authority holding the permit. Approval for discharge often requires lengthy negotiations with the Authority, designing and operating pretreatment systems for collected waters prior to discharge.

General Construction Storm Water Permits

In 1985, a significant number of states reports that storm water runoff from construction activities were a major cause of impaired waters. [7] However, the CWA did not specifically regulate these construction activities as these were not traditional point sources. As a result, the Congress amended the CWA in 1987 to expand the scope of water quality to non-point sources. [8]

The 1987 Amendments to the CWA required that the U.S. Environmental Protection Agency (EPA) develop a two-phased National Pollution Discharge Elimination System (NPDES) program for controlling the discharge of storm waters. In 1990, EPA issued requirements of the Phase I program that addressed sources of storm water runoff with the greater impact to water quality. Phase I programs included construction activities disturbing five or more acres of land. In 1999, the EPA promulgated Phase II regulations of storm water discharge that added

construction sites disturbing more than 1 acre and less than 5 acres of land. Both Phase I and II required NPDES permit coverage. [9]

The NPDES permit program for Phase I and Phase II construction sites share the same fundamental requirement of discharge under a valid general permit that identifies sediment and erosion control measures.

The general permits provide a tool used to regulate a large number of similar discharges in a region, state, or specific navigable waterway and tributary. The responsible agency publishes the general permit that contains the conditions and requirements that are form the BMPs for reaching the MEP for construction sites. Each discharger may then obtain coverage under the general permit by developing and implementing a storm water pollution prevention plan (SWPPP), filing a Notice of Intent (NOI), and complying with the permit requirements. Discharges may be subject to fees and regular inspection by agency representatives. [9]

ENFORCEMENT AND GENERAL CONSIDERATIONS

One of the many regulatory and technical issues shared by all three and impacting the cleanup activities is the compliant management and discharge of waste waters generated and resulting from the remediation activities. Multiple options were available for each closure site in resolving waste water management challenges depending upon the base regulatory framework defined for the cleanup or closure of the site. These options are typically regulated by the federal Clean Water Act (CWA), with exemptions available under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) or Memorandum of Understanding (MOU) between regulatory agencies. In general, all parties must demonstrate equivalent compliance when concerns related to the protection of the general public and the environment. As such, all options for management of waste water resulting from closure activities must demonstrate compliance to or equivalent actions under the CWA. [10]

Environmental remediation of three different radioactive waste closure sites each required exhaustive characterization and evaluation of sampling and analytical information in resolving regulatory and technical issues that impact cleanup activities. Of the three sites, different compliance strategies were employed for each.

SITE ONE – COLUMBUS CLOSURE PROJECT

For the first site, the approach for the Columbus Closure Project (CCP) was to initiate full scale compliance to the Ohio EPA General Construction Permit No. OHC000002. The general permit was issued by the Ohio EPA in compliance with the provisions of the federal Water Pollution Control Act, as amended by 33 U.S.C. Section 1251 et. seq. and the Ohio Water Pollution Control Act. [11] Storm water discharges associated with construction activities and located within portions of the Olentangy River Watershed are subject to the NPDES process. Discharges are then associated with construction activities that enter the surface waters of the state or a storm drain leading to the surface waters of the state. Further, the general permit is applied to all construction activities disturbing one or more acres of total land located fully or partially within the permit area of the Olentangy River and tributaries. [12]

Operations under the general permit are condition upon the following:

- Payment of applicable fees,

- Submittal of a completed Notice of Intent (NOI) application form,
- Inclusion of an approved SWPPP, and
- Written approval of coverage from the Director of Ohio EPA in accordance with Ohio Administrative Code (OAC) Rule 3745-38-03.

[12] The general permit also allows for discharges of uncontaminated groundwater from trenches and deeper excavations not contaminated with process or site contaminants. [12] For these reasons, the CCP opted to develop an SWPPP and provide NOI to discharge under the general permit. The SWPPP was developed to limit discharge from contaminated surface areas, trenches, and deeper excavations by physically isolating through BMPs waters of said areas, collecting and treating them prior to discharge under the Site NPDES.

Site Background

The CCP site was located approximately 0.8 kilometers south of Interstate 70 and extends from Plain City-Georgesville Road eastward of the Big Darby Creek. Within the CCP was the Nuclear Sciences Area (NSA). The NSA was a 10-acre, fenced site consisting of four buildings and several small structures located on a flat bluff. Silver Lake lies to the south and the Big Darby Creek lies to the east of the site. The land to the east, within the Big Darby Creek floodplain and along the bluffs to the east of the creek, was heavily vegetated with deciduous trees, shrubbery, and high grasses. Surface storm drains were located at various locations across the site and discharged to Silver Lake. Storm water runoff from the filter bed area on the west side of the site flowed overland to the Big Darby Creek.

Construction activities at the site were performed under contract by the U.S. Department of Energy (DOE). The project included the excavation of piping and manholes in designated areas and demolition of four buildings at the Battelle Columbus Laboratories Decommissioning Project (BCLDP) West Jefferson NSA. Clearing, grading, and excavation during construction disturbed more than one acre of the approximately 10 acre total land area of the site.

Activities conducted prior to NOI under the general permit disturbed land areas less than 1 acre. When it became evident that the construction activities would disturb more than one acre, efforts were initiated to begin preparation of this SWPPP and NOI for coverage under the general permit. Battelle Memorial Institute, the site owner, held an NPDES discharge permit for the entire Battelle site, including the active research facilities located to the south of the NSA. However, capacity of the NPDES permit excluded discharge of the construction storm water runoff.

Management of Construction Storm Water Discharge

The SWPPP for the CCP included a copy of Permit No. OHC000002, the completed NOI, and the Notice of Termination form. The SWPPP identified the potential sources of storm water pollution from the construction project, while establishing preventative measures and procedures for preventing storm water pollution.

Under the SWPPP, potentially affected construction storm water was segregated from unaffected construction storm and ground water. Potentially affected water was considered water with contact exposure to soil that could contain radioactivity. Affected water may have contained very low levels of radioactivity above background levels but well below the site volumetric release criteria set by Department of Energy. Water not meeting the unaffected criteria (“no rad added”) was filtered and released only through an approved off-site Publicly Owned Treatment Works (POTW). All radioactively contaminated water (above the site volumetric release criteria) was

managed through the Site Low Level Waste (LLW) program. Only construction storm and ground water at or below natural background levels of radioactivity was eligible for discharge under the SWPPP and the General Storm Water Permit.

Best management practices followed during the construction phase for unaffected areas included the following:

- Minimizing the areas of disturbance,
- Placing silt fencing and/or straw barriers along the perimeter of the area to be cleared and graded before any clearing or grading was performed,
- Placing silt fencing around all existing storm water catch basins and along potential pathways for overland runoff to surface water.
- Using temporary holding tanks will be utilized to store storm and ground water that enters the trenches and deep excavations until such time as the collected water could be evaluated against numerical discharge criteria,
- Sloping of all final grade to encourage drain toward catch basins,
- Stabilizing areas after final grading had been completed, and
- Covering soil piles with plastic sheeting to prevent erosion and to prevent storm water from coming into contact with the soil.

Construction storm water management under the SWPPP continued throughout the duration of the project without incident. The CCP met all conditions precedent for discharge under the General Construction Permit No. OHC000002. Several million gallons of construction storm water discharges were conducted throughout the project without incident.

SECOND SITE – LI TUNGSTEN SUPERFUND SITE

For the second site, the Li Tungsten Superfund Site in Glen Cove, New York, the option was to manage and discharge waste water under a due diligence process to New York State General Permit No. GP-02-01. Permit No. GP-02-01 is issued under authority of New York's State Pollutant Discharge Elimination System (SPDES) as an EPA NPDES-approved program according to Article 72 the Environmental Conservation Law (ECL) of the State of New York. Discharges from construction sites may obtain coverage under the general permit by submitting an NOI to the New York State Department of Environmental Conservation. Construction activities may involve any amount of disturbed acreage, provided that all eligibility conditions of Subsection B of Part I of the permit are satisfactorily met. [13]

Subsection B of Part I of the permit includes the following eligibility requirements:

- Non-storm water discharges only from construction activities, expect from fire-fighting and related maintenance, dust control, cleaning of buildings and pavement, and other similar maintenance tasks, and
- Ineligible discharges, that include those that would either cause or contribute to a violation of water quality standards adopted pursuant to the ECL and its accompanying regulations.

[13] Inclusion of the second limitation, the general permit excludes MEPs in controlling construction storm water discharges but eliminates the application to areas of land that may exhibit residual contaminants. The application of the general permit to the LTSS would be limited to those areas have been demonstrated to be free of residual site contaminants. As such,

due to the superfund status of the site a combination of discharge against MEPs and adhering to the principles of the general permit were selected for the LTSS remediation.

Site Background

The Li Tungsten Site is located in a commercial area along the north side of Glen Cove Creek in the city of Glen Cove on Long Island, New York. The site located in an area of light and heavy industry, commercial businesses, a sewage treatment plant, a Nassau County public works facility, and five State or Federal Superfund sites. Remediation activities were conducted directly adjacent to tributaries of the Long Island Sound. Historical operations involving the milling of tungsten ores resulted in residual radioactive and metals contamination at the site. [14]

Physically, the site occupied approximately 26 acres that were divided into four parcels designated A, B, C, and C'. Parcel A contained most of the buildings on the Site and was the location of the main operations center for the facility. Parcel B was generally undeveloped and contains a small pond, intermittent stream and a small wetland. Separate areas of Parcel B were used for parking, disposal, and employee picnicking. Parcel C includes two larger structures (the Benbow Building and the Dickson Warehouse), former surface water impoundments, and former locations of three above ground storage tanks. Parcel C' was not part of the active facility. [14]

In 1999, the EPA issued a ROD for the Li Tungsten Superfund Site. An Administrative Order, Index Number 02-2000-2037, dated October 5, 2000, which was issued to a number of potential Respondents. A Final Remedial Design (FRD) for Parcel B and Upper Parcel C of the site was submitted to the EPA on January 3, 2002. The FRD was approved by the EPA in 2002. [15]

In May 2005, the EPA, Region 2, issued an Explanation of Significant Differences (ESD) concerning the site. The ESD was issued in accordance with Section 117(c) of the CERCLA and Section 300.435(c)(2)(I) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The ESD revised the selected remedial action to address the City of Glen Cove's decision to revise the Glen Cove Creek waterfront revitalization plan to include residential future use of the Site. The ESD changes to the soil cleanup levels for the radionuclide of concerns set new criteria for Radium-226 and Radium-228 combined to be less than 0.18 becquerels per gram (Bq/g) (background); Thorium-230 and Thorium-232 combined to be less than 0.18 Bq/g (plus background).(EPA REF) The lead and arsenic cleanup levels remained without revision. Further, the selected remedy of excavation and removal of residual contamination to the cleanup levels remained without revision. [16]

Management of Construction Storm Water

Significant challenges arose concerning the discharge of storm waters during the construction remediation of the site. Specifically, the removal of vegetative covers and steep sloping over much of the site disturbed the natural surface flow. During inclement weather heavy runoff would be produced from upslope properties and across the site. Initial operations at the site involved the collection of storm water into artificial ponds located on down slope, lower portions of Parcel B and C'.

Construction storm water management at the site included managing and discharging waste water under a two step process of collection and diversion. Initially, management tasks involved diversion of storm waters from areas exhibiting residual radioactive and metals contamination to the artificial ponds. Water collected in the artificial ponds was transferred by filtered pumps into holding tanks. Waste water from the tanks was then samples and released in batches against the

numerical release standards negotiated with the EPA. This process reflected the MEPs exclusion of the general permit.

Construction storm water management also included the implementation of BMPs under the site water management plan (SWMP). The substantive intent of the SWMP was to demonstrate storm water and surface water run-on from Parcel C' and B could be diverted from remediated portions of the site without treatment. Best management practices following the guidelines detailed in the technical standards for erosion and sediment controls as provided in the New York State SPDES General Permit for Storm Water Discharges from Construction Activity, Permit No. GP-02-01. Actions taken concerning the specific task of diversion from clean areas at the site met the intent of Permit No. GP-02-01, including as a minimum:

- Implementing diversion controls to minimize turbidity;
- Performing regular inspection and maintenance of diversion controls implemented at the site;
- Maintaining water quality conditions; and
- Maintaining monitoring records detailing duration of diversion.

The SWPM was developed in conformance with the technical standards referenced within Permit No. GP-02-01. Application of the standards provided for eliminating or significantly minimizing pollutants, while achieving the general objectives of controlling pollutants in storm water discharges from construction activities.

Characterization sampling and scanning data were collected from each area prior to allowed direct discharge from any particular area. Data included the following types:

- Metals Remedial Action Survey (RAS),
- Gross Gamma Walkover Survey,
- Radiological Final Status Survey (FSS) Sample, and
- Metals FSS Samples

Reported data covered portions of the site and were presented in a series of technical memorandum. Data summary sheets and maps were included with each memorandum to document the interim status of each area of the site. Figure 1 depicts a portion of the southwest portion of Parcel C that detailed the metals scans of the site. In each case, systematic scanning and sampling demonstrated that each area met the ROD cleanup standards for lead, arsenic, Radium (Ra)-226 + Ra-228 combined, and Thorium (Th)-230+Th-232 combined. Therefore, storm water and surfacewater run-on water for each area was diverted directly off-site following the principles of the general permit No. GP-02-01.

SITE THREE – MIDDLESEX SAMPLING PLANT

For the third site, the Middlesex Sampling Plant in Middlesex, New Jersey, the options was to manage and discharge waste water to the Publicly Owned Treatment Works (POTW). The POTW is owned and operated by the Middlesex County Utility Authority (MCUA) under the NPDES process regulated by the New Jersey Department of Environmental Protection (NJDEP).

Site Background

The MSP site is located at 239 Mountain Avenue in the Borough of Middlesex, Middlesex County, New Jersey (NJ), approximately 28.9 km southwest of Newark, NJ. MSP is listed on the USEPA National Priorities List (NPL). [17]

The 9.6-acre site is surrounded by a 2.1-meter (m) chain link fence. Most of the site was covered by asphalt and concrete surfaces, including foundations of former buildings. Construction activities at the site involved clearing and grubbing, breaking and removal of building foundations and asphalt, and excavation, loading, and removal of contaminated soils. Final construction activities involve backfilling and grading of the site. [17]

The site surface sloped gently toward the south at an approximate grade of one percent, and was underlain by three abandoned storm water drainage lines. Although disconnected from the storm drainage lines, a sump in the slab of the former process building also discharged water to the subsurface storm water system. Due to concerns about radionuclide migration, the storm water system was plugged with concrete in 1996 and the Wood Avenue drainage pipe was rerouted along the eastern perimeter of the site. [17]

A settling basin near the southern site boundary received storm water runoff from the surface water collection system surrounding the two asphalt pads. The settling basin discharges to the South Drainage Ditch through a concrete headwall on the south site boundary. The South Drainage Ditch flows through a field to Main Stream. Main Stream then flows in a southwesterly direction through a wooded area and discharges into Ambrose Brook. An in situ granular activated carbon filter was installed behind the drainage ditch headwall in 1996 to reduce the potential for off-site migration of radionuclides through surface water media. [17]

MCUA Temporary Approval for Discharge

The project obtained temporary approval from the MCUA for discharge of storm water and ground water to the sanitary sewer and the MS4 NPDES permit. Specific approval was provided to the project with a designated flow rate and daily flow limit. The temporary approval required the collection of all storm water and groundwater with treatment through an approved, on-site water treatment process prior to discharge to the POTW. Sampling regimen were required for listed parameters. Parameters included:

- Metals
- PCBs/pesticides
- Total toxic organic compounds, including volatile organics, acids, base/neutral
- Total petroleum hydrocarbons,
- Gross alpha/beta, and
- Uranium, thorium, and radium

[18] Discharge under the temporary approval was given for the duration of the project. Weekly sampling and analysis for radiological parameters is required in addition to monthly sampling for all other listed parameters in the MS4 NPDES permit. The MCUA charged the project a per volume fee and required iterative approval prior to batch discharge.

Management of Construction Storm Water

The project constructed a water treatment system (WTS) at the site prior to initiating construction activities. The WTS consisted of sequenced micron-size bag filters and activated carbon canister filters. The water treatment method using the bag and activated carbon canister filters were sufficient to remove suspended particulate and non-soluble non-soluble radium and natural uranium contaminants. Ion Exchange Column(s) were incorporated into the WTS in order to remove known or suspected dissolved or soluble uranium contaminants. Filtered water will be

pumped into a large 378,000-liters (l) holding pool for batch sampling and discharge under the temporary approval from the MCUA.

Two, 75,600-l FRAC tanks were located near the excavations to collect water drawn directly from the excavations and post-filtration of water. The two FRAC tanks were latter replaced with the 378,000-l holding pond.

Filtered water was sampled and analyzed prior to each discharge event as detailed in the temporary discharge approval obtained from the MCUA. Filtered and tested water was discharged into the sewer line onsite or at an alternate effluent point.

Initially, each 75,600-l discharge was analyzed for all parameters anticipated under the approval from the MCUA. Full analysis continued for the first 2,835,000-l discharged under the approval. Analysis was then downgraded to chemical parameters, isotopic uranium, isotopic thorium, and isotopic radium for every 378,000-l of filtered water discharged under the approval. Gross alpha/beta analysis will continue to be performed on the same frequency. This protocol will be applied to discharges throughout the project.

Water management strategies were strictly implemented during the remediation of the site. Areas of excavation were minimized to reduce the impact of water from storm water and ground sources. Open excavations were minimized, with the deepest point of the excavation lying in the east and the south portion of the excavation. This drove groundwater to the point of least hydraulic resistance into the lower portion of the excavation. Surface water run-on was controlled using temporary barriers of sandbags or similar materials. Trenching around the excavation was also performed to divert surface flows.

To date more than 4.9 million liters of water have been compliantly discharged under the MCUA permit.

IMPACT OF RAPANOS V. UNITED STATES

The most recent and significant environmental case potentially impacting the regulation of construction storm water management activities involved four Michigan wetlands lying near ditches or man-made drains that eventually emptied into navigable waters. The slim majority ruling of the Court provides little clarity concerning the application of the CWA. This Author's reading of the case lends towards a fractured decision littered with political leanings that leave the lower courts and government agencies the challenge of effective implementing the decision while protective one of our Nation's greatest limited resources. Further, the lack of legal clarity may in the end impact the protections achieved under the Phase I and II construction storm water management regulation.

In Rapanos v. United States, petitioner John A. Rapanos backfilled three of four wetlands on parcels of land near ditches or man-made drains that eventually emptied into traditional navigable waters. The United States brought civil enforcement proceedings against Rapanos, who had backfilled the wetlands without a permit. The U.S. District Court found federal jurisdiction over the wetlands because of the contiguous nature to the "waters of the United States" and held Rapanos in violation of the CWA. Affirming, the Sixth Circuiit affirmed finding that the parcels hydrologic connections to the ditches or drains and therefore under the jurisdiction of navigable waters. [19]

The U.S. Supreme Court vacated the ruling of the Sixth Circuit, citing that by including "ephemeral streams, wet meadows, storm sewers and culverts, directional sheet flow during storm evens, drain tiles, *and* man-made ditches,…"in the definition of "the waters of the United States," the U.S. Corps of Engineers went too far in asserting federal jurisdiction under Section 404 of the CWA. [19]

In Justice Scalia's plurality ruling, focuses upon the definitional character of navigable waters rather than quality or protection standards. In defining "the waters of the United States", the ruling draws out the restriction to "exclude channels containing merely intermittent or ephemeral flow. These are held to include ephemeral streams, wet meadows, storm sewers and culverts, direction sheet flow during storm events, drain tiles, and man-made ditches. Jurisdictional determination of the CWA is that waters must be navigable in fact or susceptible to being rendered so, thus excluding ephemeral waters. Justice Scalia clouds this definition by arguing that while intermittent or ephemeral streams are not waters of the United States, such water bodies may still be considered under jurisdiction of the CWA to the extent that they convey pollutants to navigable waters. [19]

Justice Scalia's opening provides access to Justice Kennedy's "significant nexus test" in the concurrence opinion. Under the test, to constitute "navigable waters under the Act, a water or wetland must possess a significant nexus to waters that are or were navigable in fact or that could reasonably be so made." The test relies on demonstrating that "the waters" extend to those that "significantly affect the chemical, physical, and biological integrity" of navigable waters of the United States. [19]

Rapanos is applied to the jurisdiction under the definition of navigable waters under Section 404 of the CWA. The same definition is applied to Section 402(p) in the federal regulation of storm water discharge. As such, there remains the possibility that post-*Rapanos* enforcement actions under Section 402(p) may not withstand. Storm water regulations and enforcement may be susceptible to challenges under several fronts. First, impacted parties may argue that federal regulation of storm water discharges is inappropriate as these often are applied to nonnavigable, intrastate waters. Such a broad challenge would be unlikely as most construction sites ultimately discharge into traditional navigable waters. Jurisdictional challenges may also be raised in that construction storm water discharges involve sheet flows off the site into ditches and drains that may or may not eventually reach municipal storm water sewer collection systems before reaching traditional navigable waters. Thus, the determinative application to sites based upon size has little or no relation to whether the storm water discharge may ultimately reach navigable waters.

Whether *Rapanos* results in results in expanding litigation and diminishing protection of water resources remains to be seen. Individuals or parties seeking to discharge under NPDES or general permits should continue to monitor compliance status and changing regulatory requirements.

CONCLUSIONS

Comprehensive and aggressive storm water management strategies were employed throughout the remediation of the three different radioactive waste closure sites. For each site, consistent implementation of SWPPPs and technology systems allowed remediation to proceed on schedule and provide unique and often cost-effective options for water management. Constantly exploring the various options that existed for each of the three sites enabled each to control and minimize the impact of construction activities to surface water quality standards. Tailoring the regulatory

approach and the storm water management practices to the conditions and challenges of each site also maximized compliance.

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