Washington State DOT Meets the Challenge of Hazardous Waste

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Geotechnical exploration during design of the $100 million Tacoma Spur Freeway (SR 705) revealed unexpected coal tar contamination. This discovery was traced to a long-abandoned coal gasification plant which operated on the site around the turn of the century. Further discoveries during construction included two large, buried tanks filled with tar waste, and copper contamination from ore spilled in an old train derailment. A three-year cooperative effort by the Washington State Department of Transportation (WSDOT) and the Washington State Department of Ecology (WDOE), assisted by a hazardous waste consultant, ensured that design and construction proceeded with minimal delay. Solutions produced by the joint effort included three specially designed on-site concrete vaults for storing 26,450 tons of problem waste and the removal of 15,900 tons of extremely hazardous waste to a hazardous waste facility in Arlington, Oregon. In addition, 1300 tons of copper-contaminated soil were removed and transported to a smelter in El Paso, Texas, for recovery of the ore. Total project cleanup costs were almost $6 million. Long-term groundwater monitoring has been planned and is expected to show a significant decrease in previous contaminant concentrations reaching the adjacent City Waterway.

During design of the $100 million Tacoma Interstate Freeway Spur (SR 705), geotechnical exploration revealed the presence of black "mystery gunk." The discovery led to extensive investigation and problem solving in the Washington State Department of Transportation's (WSDOT) first encounter with hazardous waste. A coal gasification plant, built on the site about 100 years ago, was identified as the source of the contamination. Coal tar waste containing polycyclic aromatic hydrocarbons (PAH) was identified as the contaminant of most concern, leading to an extensive site cleanup program. Cleanup of the tar and other contaminants found on the site added almost $6 million to the cost of the project. However, knowledge gained during work on this project has been invaluable in developing criteria for addressing any future discoveries of hazardous waste on WSDOT projects.

This paper presents a case history of the remedial investigation and site cleanup on the Spur project. Special emphasis is given to the team approach used for problem solving and technical solutions to the problems.

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PROJECT DESCRIPTION

The Spur begins at Interstate SR 5, just west of the Tacoma Dome, and runs north to connections with the Tacoma Central Business District and Schuster Parkway (Figure 1).

The alignment crosses over reclaimed tidelands lying between downtown Tacoma, located on steep rising hills to the west, and City Waterway on the east. City Waterway is a manmade, southerly extension of Commencement Bay in Puget Sound. All except a short stretch of roadway, between 15th Street and 23rd Street, is carried on elevated, reinforced concrete structures. Previous uses of the land below included extensive rail trackage facilities and yards in addition to numerous industrial and commercial activities.

The project has been constructed in six stages, in separate contracts. Stage 1, the Tacoma Dome off-ramp, began in 1982 and was completed in 1983 to coincide with the opening of the Dome. Stages 2 through 5, the remainder of the Spur, were still under construction when this paper was written. The contract phase of Stage 6, which will add an additional southbound lane to Interstate SR 5 and ensure safe access to and from the Spur, began late last year.

DISCOVERY OF THE PROBLEM

In February 1984, during drilling conducted to evaluate the Spur's foundation requirements, concern arose over possible soil contamination. A tar-like substance was encountered in several borings between 21st and 24th Streets, bounded on the west by A Street and on the east by the City Waterway.

At that time, the Spur Stage 2 contract was being advertised for bids. Contract documents for Stages 3, 4, and 5 were being developed on a fast track schedule for advertisement in the summer and fall of 1984.

At WSDOT's request, samples of the suspect material were tested by the Washington Department of Ecology (WDOE). Test results confirmed the presence of toxic chemicals, including 13 polycyclic aromatic hydrocarbons (PAHs).

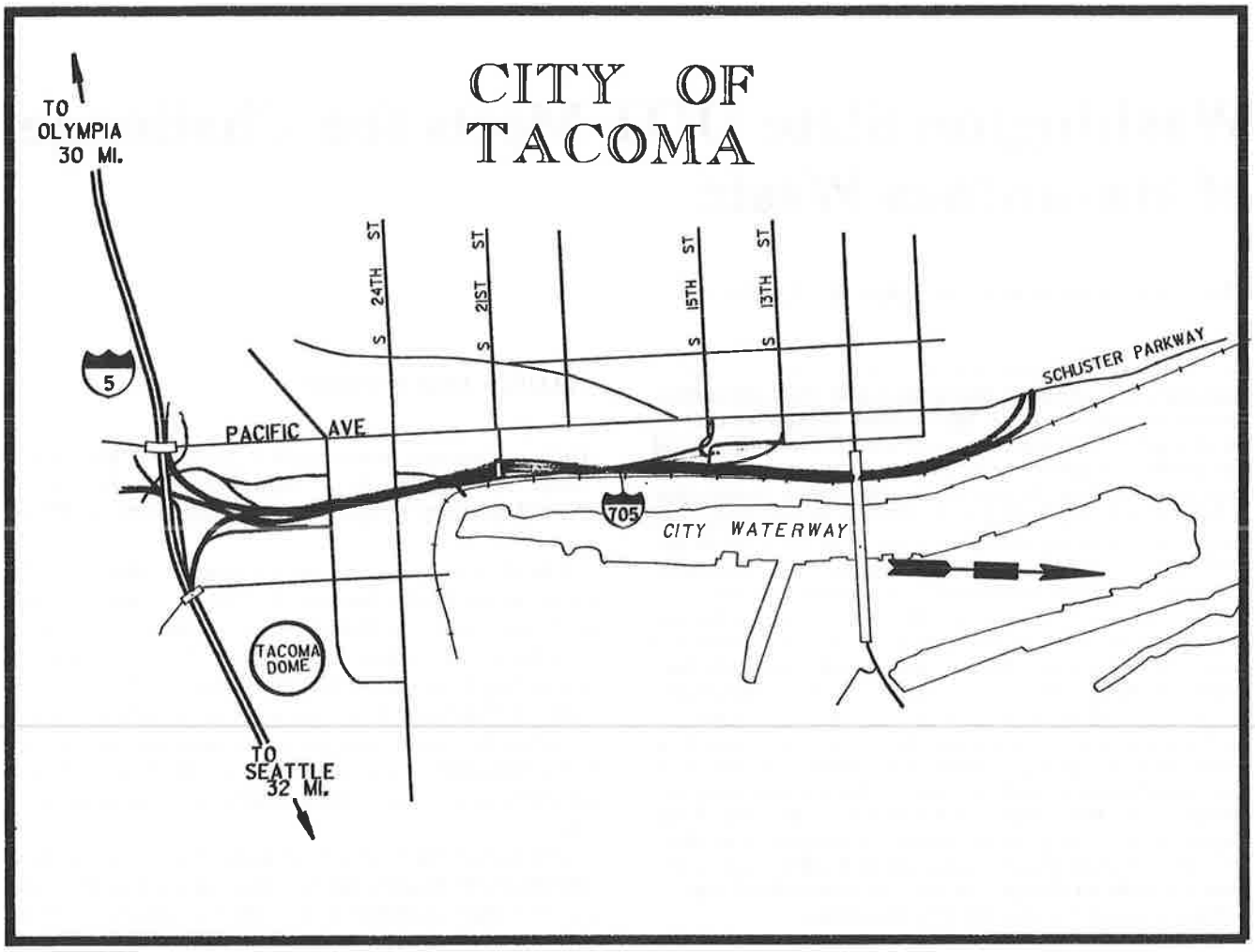

FIGURE 1 Tacoma Spur alignment.

In April 1984 representatives of WSDOT and WDOE met and defined mutual objectives. These were determined to be as follows:

(1) evaluate and address the potential for adverse environmental impacts,
(2) ensure the safety of the public and those involved in constructing the project,
(3) keep construction of the Tacoma Spur on schedule, and
(4) keep the public informed as to the problem.

Solving and managing the hazardous waste problem and fulfilling these objectives was a team process from the outset. Many of the ensuing activities were virtually a pioneering effort. No clear-cut criteria were available for handling this type of situation, as environmental regulations leave much room for interpretation.

Soon after the April meeting, Hart Crowser, Inc., a Seattle firm with considerable experience in hazardous waste matters, was hired by WSDOT to help evaluate the problem.

Hart Crowser was asked to conduct a soil and groundwater quality evaluation of the site. The evaluation was to include a historical review, determination of location, degree of contamination, and a quantitative assessment of the current and future migration of these contaminants into the City Waterway. The evaluation report was completed in November 1984.

History of the Site

Hart Crowser reviewed newspapers, books, reports, maps, and photos to reconstruct the history of the site.

The site was originally tidal land, the subsurface of which contained overconsolidated glacial deposits (till and silts) underlying more recent soft sediments. The area had been used for industrial purposes since the early days of the City of Tacoma, but was extensively filled later. The original tidelands were now covered by 2 to 50 feet of fill material.

In the late 1800s, the site was occupied by a coal gasification plant built to supply water gas for lighting and

heating a growing Tacoma. Water gas (primarily a mixture of hydrogen and carbon monoxide) is a combustible fuel produced by passing pressurized, superheated steam through a bed of mixed coke and coal.

Most of the plant was located between South 21st and South 23rd Streets next to A Street (Figure 2). Review of historical files and SANBORN insurance maps revealed that two gas holding tanks and a tar pump area had been used during plant operations from 1884 through 1924. A third tank was built on the site sometime between 1928 and 1930. Figure 2 shows the tank locations.

The coal gasification plant, including the original two holding tanks, was abandoned after 1924, when a more modern plant was constructed in a different area of Ta-

Base map prepared from USGS 7.5-minute quadrangles of Tacoma North and Tacoma South, Washington.

FIGURE 2 Vicinity map.

coma. The third tank appears to have been used well into the 1940s, perhaps as storage for gas produced elsewhere. At that point, it too disappeared from the scene.

The gasification plant was all but forgotten until preliminary substructure borings for the Tacoma Spur revealed what the newspapers reported as a black "mystery gunk."

Site Contamination

A series of 29 soil borings/monitoring wells was used to define the types and extent of soil and groundwater contamination. Priority pollutant analyses based on both organic vapor readings and on visual classification were made on selected samples. Analyses findings were compared with the list of contaminants likely to result from coal gasification activities.

Discussions with WDOE resulted in narrowing the contaminant focus to polycyclic aromatic hydrocarbons (PAH), trace metals, and selected volatile organics. The analyses showed that polycyclic aromatic hydrocarbons (PAH) were the contaminants of most concern. These compounds have been identified as hazardous constituents in coal tar waste and can constitute up to 12 percent of the tar by weight. Washington State dangerous waste regulations (WAC 173-303) classify waste containing 1 percent or more total PAH (as quantified by WDOE's PAH test) as extremely hazardous waste. Lower concentrations are not officially classified but are generally referred to as problem waste. Problem waste materials fall into a gray area which contains no clear cut regulations to guide disposal: they are not entirely clean, yet at the same time not dirty enough to necessitate the stringent disposal procedures required for extremely hazardous waste.

Metals, volatile organics, and other contaminant concentrations found were judged to fall below federal and state waste and drinking water classification standards.

Soil Contamination

One of the first objectives of the project was to assess the extent of coal tar waste in the soil. The results of the priority pollutant analyses and WDOE's PAH waste classification test led to the identification of the following three categories of contamination in the soil:

- Tar: These were visually identifiable as tar or tar-like material. These materials generally had PAH concentrations in excess of 1 percent and were classified as extremely hazardous waste.
- Oily silt or sand: These materials were generally dark to black in appearance and had a strong creosote-like odor. Because the PAH concentrations were below 1 percent, oily silt or sand were classified as problem waste.
- Odorous materials: These materials had no visual sign of contamination and PAH concentrations were under 5 mg/kg. Because of the low PAH concentration levels, these materials were classified as solid waste.

The extent and distribution of these materials were initially estimated based on the results of the soil borings and lab results (Figure 3). Levels and types of contamination were estimated by interpolation between the borings, resulting in an estimate of 40 to 100 cubic yards of tar and 4,500 to 6,000 cubic yards of oily silt or sand.

Groundwater Contamination

Water samples taken from the boring wells indicated only mildly elevated levels of PAH or metals contamination. There were no measurable impacts on either surface water or groundwater users. These conclusions were based on water levels, soil boring logs, and in-site hydraulic test data used to characterize the groundwater flow conditions. Water quality analyses were performed on selected samples. The hydrology of the site was relatively straightforward (Figure 4). Precipitation infiltrated the areas in or near the project site and then flowed as shallow groundwater in the general direction of the City Waterway, where it discharged. The project site lies in a regional groundwater discharge area. Underlying the project site was low permeability glacial till, preventing contaminated water beneath the site from flowing downward to contaminate water supply wells in the area, and allowing contamination to discharge from the site to City Waterway.

Groundwater flow rates and water quality data were used to calculate the loading rate to the Waterway. This analysis indicated that groundwater contamination concentrations entering the Waterway were below the existing salt water chronic exposure levels for marine organisms. Samples taken from the Waterway indicated no detectable concentrations of these contaminants.

Because of these results, WSDOT and WDOE were satisfied that groundwater discharge from the site presented no immediate danger to City Waterway. Therefore, the team concentrated on the problem of soil contamination.

Legal Responsibilities

The legal responsibility for remedial action on such a site is complex. State and federal law stipulate that potentially responsible parties include past and present waste generators as well as past and present owners of the site. In this case, WSDOT clearly had no role in creating the contamination. However, the need for project excavation within the contamination area would cause WSDOT to become a hazardous waste generator. WSDOT, faced with a pressing construction schedule and the potential for significant cost increases for delays, chose to pursue remedial investigation and cleanup as part of the Spur construction project. The Federal Highway Administration (FHWA) concurred in this decision.

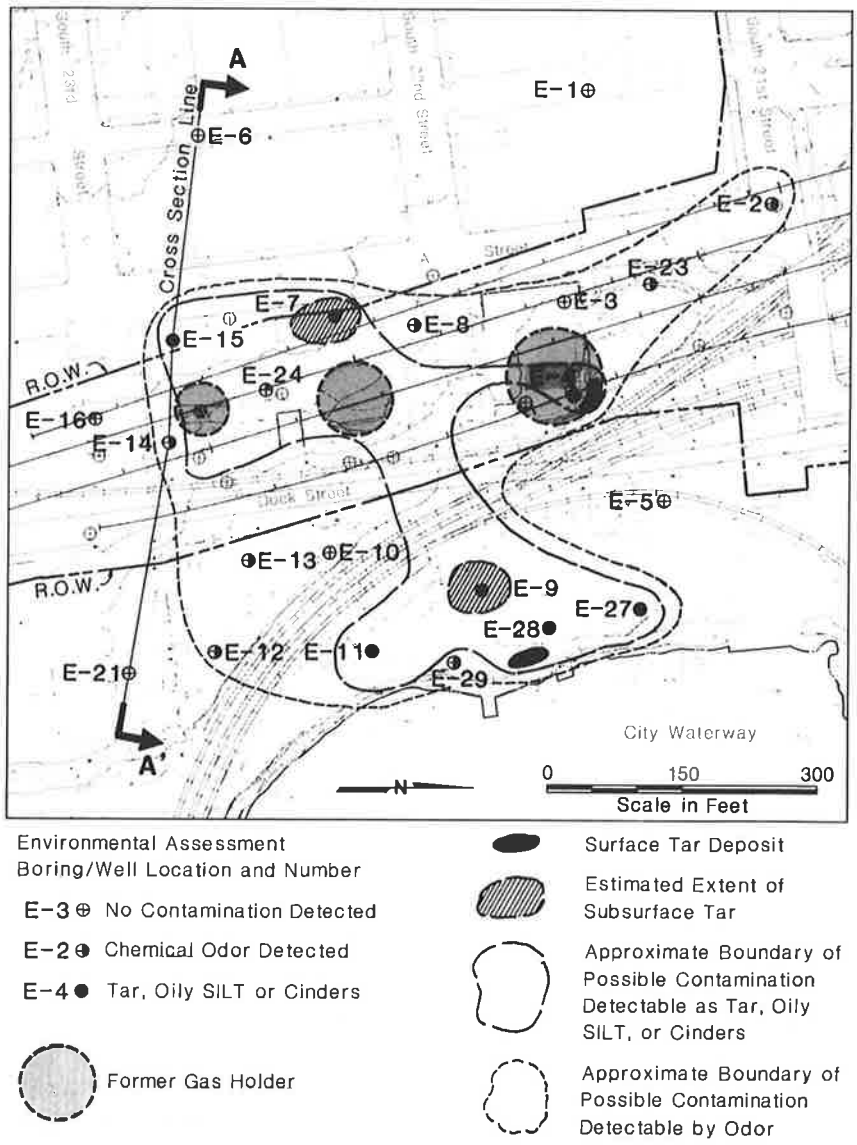

FIGURE 3 Pre-excavation estimate of subsurface contaminants.

Planning for Site Cleanup

The Hart Crowser investigation was followed by months of meetings among the consultant and WSDOT and WDOE staffs. Other participants included the FHWA and the Tacoma-Pierce County Health Department (TPCHD). During this process, the public was kept informed through a series of joint WSDOT-WDOE press releases.

Major decisions resulting from these meetings were as follows:

(1) All tar-like material encountered during construction activities would, as a designated Extremely Hazardous Waste, require disposal at an approved hazardous waste facility.

(2) Less contaminated material, identified as oily silt or sand or odorous material could be contained on site in an approved storage vault. On-site storage would require a solid waste permit from TPCHD.

(3) Visual identification methods would be used during construction to expedite safe handling and disposal of contaminated materials.

(4) Plans and provisions for handling and disposing of contaminated material would be included in the project's Stages 4 and 5 contract documents.

(5) Provision would be made for long-term monitoring of groundwater impacted by the contamination.

As plans were made for dealing with the contaminated material in Stages 4 and 5 in the summer of 1984, work began on the Stage 2 and 3 contracts. Stage 2 and 3 construction was limited to areas north of the suspected contamination.

The project team determined that contract documents for Stages 4 and 5 would include a plan showing the nature

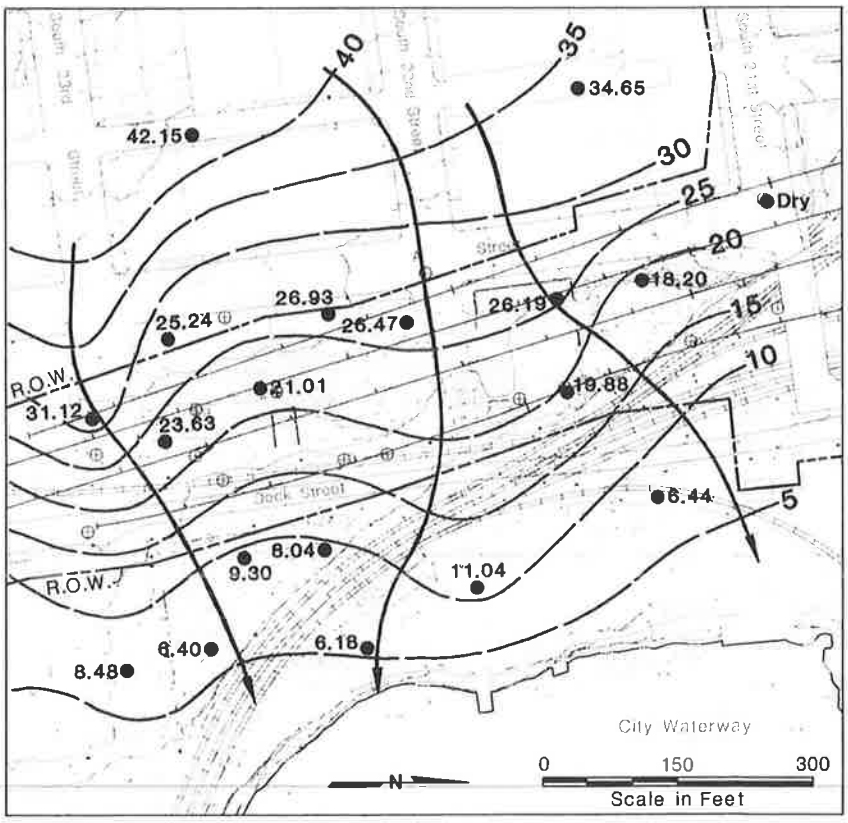

FIGURE 4 Water table elevation contour map.

and the approximate boundaries of the contamination. Provision would be made for monitoring of all excavation operations by WDOE. Contract specifications would be included for handling and disposing of all contaminated material.

The contractor would be required to hire a safety consultant to advise on safety precautions required for personnel and equipment working around the contaminated materials.

The Stage 5 contract was to include construction of a secure decontamination area. Here, personnel and equipment exposed to contaminated material would be cleaned before leaving the construction area. Plans also included construction of a concrete vault in the project area to permanently secure and encapsulate oily silt or sand encountered during excavation activities. Provision was made for a possible second vault.

Holes would be drilled and wells developed for long-term monitoring of groundwater. The wells would be located both east and west of the tar contamination site, in the on-site storage vaults, and around the storage vault area.

Stage 4 and 5 Construction Begins

In December 1984 construction began on the 21st Street Interchange, Stage 4 of the project.

No tar was found in the Stage 4 area. However, 1200 tons of oily silt or sand were uncovered during excavation, and stockpiled in a secure location for disposal in the Stage 5 contract.

In August 1985 WSDOT awarded a contract for Stage 5 of the project. Work on Stage 5, which included the Spur from 21st Street south to SR 5, began in late September 1985.

Early in the contract, an oblong, concrete storage vault (Figure 5) with a capacity of 6,000 cubic yards was constructed within the state right of way, in an open area at the south end of the project. Vault walls were 4 inches thick, reinforced by a 10-gauge, 6-by-6 wire mesh at the center. Once the vault was filled to capacity, a 4-inch reinforced slab, sloped to drain, was to be placed on top. The slab would then be covered with 10-mil polyethylene sheeting and a 2-foot layer of clean soil.

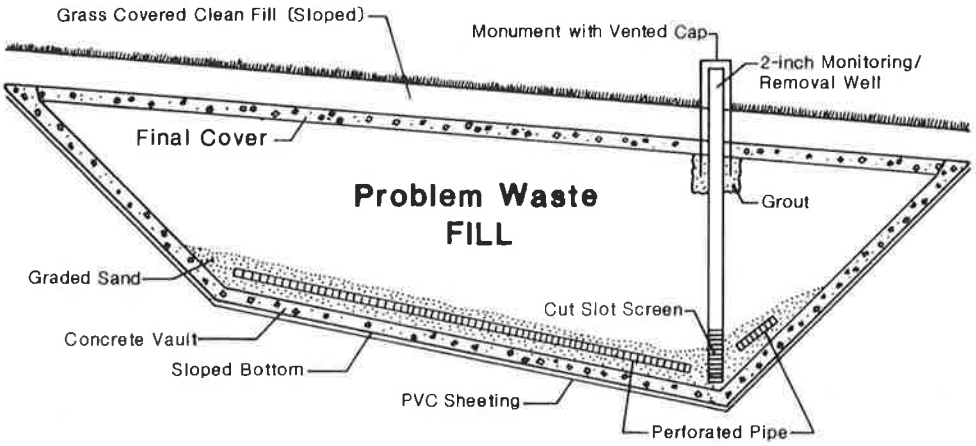

FIGURE 5 Problem waste vault schematic design.

As excavation began in the suspected contamination area, both tar and oily silt or sand were uncovered. Using procedures agreed on earlier by WSDOT and WDOE, WSDOT's inspector visually identified the type of contamination.

Tar was transported to the Chem-Security Systems, Inc., hazardous waste facility in Arlington, Oregon, for permanent storage.

Contract provisions called for transportation to be handled by a company licensed and approved by EPA and USDOT for transporting. Transport vehicles entered the project site at the decontamination area where they were fitted with a polyethylene protective liner. After being loaded with tar at the excavation site, they returned to the decontamination area. There, the exterior of the vehicle was steam-cleaned, the protective liner was sealed, and a tarp overlay was secured.

Before leaving the decontamination area, the vehicle was inspected and the driver was provided with a signed shipping manifest and approval to leave the project site. Upon the vehicle's arrival at the Arlington, Oregon waste storage facility, the load was weighed and its chemical composition was tested for conformance to a waste material profile previously furnished by WSDOT. Tar delivered to the waste facility would be only accepted in a solid state. Liquid tar encountered at the project site had to be solidified by mixing it in cement kiln dust before shipment.

Oily silt, sand, or odorous materials which were uncovered were hauled to the on-site concrete storage vault and deposited there. The procedure was subject to WSDOT's approval of the haul road, the method of placement in the vault, and the precautions taken by the contractor to prevent contamination of the surrounding areas.

Unexpected Discoveries: Storage Tanks

As the contractor pursued bridge footing excavation near 23rd Street on December 20, 1985, he encountered the brick and mortar walls of a large buried storage tank. This tank was 60 feet in diameter, 20 feet deep, and uncovered at the top. It contained 1260 tons of mixed, tar-like material.

On February 6, 1986, the contractor partly unearthed two additional open-topped, brick and mortar structures to the north of the first tank. The first structure, a container measuring 6 feet by 8 feet by 10 feet deep was filled with tar. The second, a tank 87 feet in diameter and 20 feet deep, contained approximately 5500 tons of mixed, tar-like material. Historical data had indicated that large holding tanks for gas had existed at one time in this vicinity. However, the discovery that the lower sections of the tanks were still there, buried in the ground, was a complete surprise.

The tanks had originally been built entirely above ground. The project team speculated that when the old coal gasification plant was closed, instead of removing the manufacturing equipment (tanks, pipes, sumps, etc.), the site was filled to a level 10 to 15 feet above the original surface. The pipes and lower sections of the tanks were left. Since a large amount of coal tar was originally dumped in the area, much of the fill used in the operation contained tar.

The worst material was probably placed in the tanks for containment because much of it was semiliquid and could flow. The material rested there for more than 60 years until uncovered by the Spur contractor.

Based on analyses of representative samples, all of the material in the large tanks and the smaller "tar pit" was classified by WDOE as extremely hazardous waste. In addition, much of the fill surrounding the tanks was also found to have sufficient PAH concentrations to be placed in the same classification. The edge of the area contained considerable material with lower levels of contamination, which was considered problem waste.

The unexpected discoveries caused a dramatic increase in the amount of contaminated material requiring removal during construction. This is quite evident in the comparison shown below.

	Quantities of Contaminated Material Removed (tons):	
	Maximum Expected	Amount Removed
Extremely hazardous waste	120	15,900
Problem waste	7,200	26,450

In the final tally, 731 truckloads of extremely hazardous waste were removed from the project site and hauled to Arlington, Oregon. The increased amounts of problem waste required building two additional on-site concrete storage vaults. (One vault had been called for in the contract.) All three vaults were filled to capacity by the time project excavation was completed.

Unexpected Discoveries: Copper Ore Contamination

As removal of tar-related material continued, the interagency team was busily trying to solve yet another toxic surprise. In August 1985, soon after the award of the Stage 5 contract, WDOE advised WSDOT that it had discovered soil that appeared to contain copper ore in the project area.

The copper-laden material was scattered near 26th Street in an area 300 feet by 150 feet below the bed of a single track rail line. Checking the rail line's records indicated that, over the years, this location had been the scene of a large number of freight train derailments. The cargo involved in at least one of these derailments contained copper ore.

Two bridge pier footings were to be constructed as a part of the Stage 5 contract in the area where the copper was found. In addition, major utility relocation related to the project called for extensive trench excavation through the area. The utility relocation was required to begin early in the Stage 5 contract to maintain the job schedule.

First, metal, fish bioassay and EP toxicity analyses were conducted on the soil samples. A fish mortality rate of 100 percent in the bioassay analysis led to designation of soil with a copper concentration of 9500 ppm and above as dangerous waste. This material required removal and disposal off the site.

Further testing was needed to determine the impacts of soil with lower copper concentrations. Four sampling trenches and a groundwater monitoring well were used to evaluate migration of metals into the soil in areas of high surface contamination.

Tests were conducted on samples of soil at various depths in the trenches and on water samples taken from the well. Water samples indicated no groundwater contamination: in fact, the groundwater met drinking water standards. Soil analysis results confirmed that soil with copper concentrations below 9500 ppm could be left in place with no danger of future contamination of the groundwater. As a precautionary measure, all such material left in place was covered with two feet of fine-grained material.

Several options were considered for disposal of the 1300 tons of soil with copper concentrations of 9500 ppm and above, including a recovery and recycling option suggested by Hart Crowser. This option was selected, which led to reconsideration by WDOE of the material's original designation as dangerous waste. That designation would have eliminated the option of reprocessing by any facility not approved to treat dangerous waste. After some reevaluation the dangerous waste designation was removed, based on the fact that the copper ore had been processed and was not left as waste. Although it had been spilled, it still maintained an economic value in recoverable metals.

The decision resulted in an agreement between the Stage 5 contractor and ASARCO Incorporated of El Paso, Texas. The copper-laden material was hauled by truck to an ASARCO-owned facility in Tacoma, Washington, by the contractor. There, it was loaded into freight trains and taken to the ASARCO El Paso Plant. Treatment in El Paso consisted of conventional copper smelting technology, which reduced the copper-laden soil to a marketable product and an inert slag.

Team Problem Solving

The state's successes in managing these hazardous waste problems can be attributed directly to the team effort by the agencies involved. While WSDOT had full responsibility for managing the construction project, WDOE was the regulatory agency responsible for contamination issues. All actions and responses resulted from team problem solving. Other team agency members included the FHWA and the Tacoma-Pierce County Health Department.

Through frank discussions of the issues and consideration of possible alternate solutions, the agencies were able to establish a mutual trust.

WDOE's position from the outset was one of firmness: however, it maintained a willingness to work towards cooperative solutions. In this spirit of teamwork, WDOE, despite its position as regulatory agency, established no direct requirements. Instead, it asked for proposals on the evaluative or cleanup method and then suggested modifications as necessary.

Much of the contaminated material encountered during the project did not fall specifically under Washington State's dangerous waste regulations (WAC 173-303). However, the material was clearly contaminated and a variety of regulations [i.e., federal Superfund laws (42 USC 9601) or Washington State water quality laws, (RCW 90-48)] could have been applied.

The interagency team approach allowed construction to proceed with minimal delays. Cleanup methods were developed to provide a measured response to the environmental problems at reasonable cost.

Groundwater Monitoring

Programs were developed by the team for long-term monitoring of groundwater in two distinct locations.

Five wells will be installed to monitor groundwater between the former coal gasification plant site and the City Waterway. Monitoring will reveal the effects of removing contaminated tar and soil from that site.

Well installation, sampling, and testing will end as soon as other contractor activities in that area are completed. Water quality indicator parameters (total organic carbon, total organic halogen, pH and temperature) will be measured regularly, while more major analyses (base neutral extractable and volatile organics) will be performed less frequently, using priority pollutant scans. The results are expected to show a steady decline in PAHs and trace metals over the long term, based on the removal of an estimated 95 percent or more of the PAH-bearing waste during the Spur contract.

Thirteen wells were installed to monitor possible contamination from any of the three problem waste storage vaults. Four of the wells were installed within the vaults (two in Vault #1 and one each in Vaults #2 and #3). The other nine wells were placed outside the vaults. Testing of samples from these wells has already begun, and water quality indicator parameters will be measured regularly. Increases in these parameters as they are sampled and measured will trigger additional sampling to verify those results and to examine more specific parameters.

During the initial sampling from wells within the vaults, water was found in two of the vaults. It was attributed to the presence of water in the original material, in addition to rain water entering the vaults before the top slab was constructed. The water was pumped out of the two vaults; water from one of the vaults was treated to remove contaminants before disposal. Tests of water samples from the nine wells outside the vaults have indicated no contamination.

Cost

The total cost for the hazardous waste activities of this project has approached $6 million. Cost to date:

- Handling and disposal of extremely hazardous waste (includes construction and removal of a decontamination-site, demolition and removal of the tar tanks and appurtenances, and monitoring well installation): $4,000,000
- Handling and disposal of problem waste (includes construction of three concrete storage vaults and monitoring well installation): $550,000
- Handling and disposal of copper contaminated soil: $600,000
- Treatment of contaminated water: $350,000
- Consulting services: $350,000
  - TOTAL: $5,850,000

EPILOGUE

At the time this paper was written, construction of the Tacoma Spur was still under way. However, all excavation in the vicinity of both the old coal gasification plant site and the copper contamination site had been completed. It is likely that most, if not all, of the contaminated waste material had been discovered and removed. Total cost of activities related to hazardous waste was slightly less than $6 million. Further responsibilities for monitoring groundwater in the area will continue for at least the next five years.

A team approach by the Washington State Department of Transportation and the Washington State Department of Ecology led to timely and cost effective solutions to the contamination problems. A large hazardous waste site was cleaned up, and a source of considerable potential contamination of Tacoma's City Waterway was essentially eliminated.

Separation of the contaminated material into extremely hazardous waste and problem waste sharply reduced the total cleanup costs. Using on-site concrete vaults to permanently store problem waste effectively isolated that contamination from its surroundings. The cost of building the vaults and depositing the problem waste on site was $6 million lower than the cost of transporting and disposing of the same amount of material at the hazardous waste site in Arlington. Another significant factor of the separation concerned WSDOT's long-term liability for both forms of tar related contamination.

Should future laws require further action for either extremely hazardous or problem waste, the state's separation of those materials will enable proper action to be taken.

From the experience gained on the Spur Project, WSDOT has developed a Hazardous Waste Response Program, which includes WSDOT "Hazardous Waste Guidelines." The guidelines describe general procedures to be used if hazardous waste is discovered on future WSDOT projects, and address both the design and construction phases of a project. Technical support will be available for future projects through an on-call agreement between WSDOT and a hazardous waste consultant.

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