Surface Soil Risk Screening and Focused Feasibility Study for Interim Action Northwest Pipe Company, Portland, Oregon

PREPARED FOR: Jim Orr, R.G./Oregon Department of Environmental Quality

PREPARED BY: Nathan Williams, P.E./CH2M HILL
Jeff Schut/CH2M HILL
Rob Healy, R.G./CH2M HILL
Ken Shump, R.G./CH2M HILL

COPIES Carol Grant/Northwest Pipe Company
Stephanie Heldt/Northwest Pipe Company
Claudia Powers/Northwest Pipe Company

DATE: May 27, 2010

1.0 Introduction

CH2M HILL, on behalf of Northwest Pipe Company, has prepared this risk screening evaluation (RSE) and focused feasibility study (FFS) to develop and evaluate interim remedial options to address surface soil that locally contains polynuclear aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) at the Northwest Pipe Company Portland, Oregon facility.

This technical memorandum presents a focused evaluation of interim remedial alternatives for surface soil and presents a recommended surface soil interim remedial alternative. This recommendation is based on information presented in the following documents:

- *Interim Report Summarizing Additional Soil and Roof Runoff Investigation Results* (CH2M HILL, 2010)
- *Supplemental Site Characterization Results, Northwest Pipe Company, Portland, Oregon* CH2M HILL, 2008)
- *Remedial Investigation/Source Control Evaluation Report Northwest Pipe Company Portland, Oregon* (CH2M HILL, 2005a)

2.0 Background

Portland facility is located in the area generally referred to as the "Burgard Industrial Park" in the northern part of Portland, Oregon. The facility is located approximately 1,500 feet away from the east bank of the Willamette River, borders no surface water body, and is situated between two manmade slips: the Terminal 4 Slip 1, owned by the Port of Portland, and the Schnitzer International Terminals Slip, owned by Schnitzer Investment Corporation. Some properties in this area, including the Northwest Pipe facility, share the street address 12005 North Burgard Road. A site location map is shown in Figure 1. The property now owned and used by Northwest Pipe Company has been used for heavy industrial activities for nearly 70 years. It was first developed during the early 1940s as a portion of the Oregon Shipbuilding Corporation's operations, and has been under industrial use ever since. Northwest Pipe Company did not begin operations at the site until 1982.

Northwest Pipe Company has collected soil samples at numerous locations and various depths to support site management, soil removal activities, and to address Oregon Department of Environmental Quality (DEQ) requirements for site characterization as part of the Remedial Investigation/ Source Control Evaluation (RI-SCE) process. The results of this work show that soil locally contains detectable concentrations of PAHs and PCBs; however, constituent concentrations decrease rapidly with depth, and concentrations above screening levels typically are located in the upper foot of soil. This finding led to this document's focus on surface soil. Figure 2 shows the surface soil sample locations. A detailed discussion of surface soil analytical results compared against preliminary screening level values (SLVs) is presented in *Interim Report Summarizing Additional Soil and Roof Runoff Investigation Results* (CH2M HILL, 2010).

3.0 Updated Risk Screening Evaluation

This section provides a focused conceptual site exposure model and summarizes the results of the updated human health risk screening evaluation (RSE), which is being conducted in support of the FFS. A conceptual site exposure model has been previously provided for the site as part of the human health and ecological risk screening conducted as part of the RI-SCE (CH2M HILL, 2005a). Additionally, the risk screening for the RI-SCE was predated by an ecological risk scoping (CH2M HILL, 2005c) at the site. Where applicable, and to avoid presentation of extraneous information, site details from previous evaluations are referenced.

This RSE was completed at DEQ's request to determine if a more detailed risk assessment might be warranted and to help Northwest Pipe and DEQ decide if an interim remedial measure might be appropriate. Although the screening levels used in this RSE are considered protective of human health, they should not be construed as site cleanup values.

The overall objective of this RSE is to determine the potential for contaminants of interest (COIs) in soil to pose a potential for unacceptable risk to human health, and if so, whether COI levels are high enough to be considered "hot spots" as defined in *Oregon Administrative Rule* (OAR) 340-122-115(32). Because the FFS has been drafted for remedy selection to address soil, this RSE, which evaluates possible interim remedial alternatives to be implemented before completing the final remedial investigation/source control evaluation, is similarly limited to soil. The RSE was performed in accordance with OAR 340-122-080(5).

3.1 Data Evaluation

Analytical data considered in this soil screening risk evaluation are from the following sources:

- 1988 Phase II site investigation

- September 2001 site characterization
- August 2002 subsurface soil sampling
- June 2005 surface soil sampling
- October 2006 surface soil sampling
- September 2007 surface and subsurface soil sampling
- January 2008 surface soil sampling
- October 2009 surface soil sampling

Surface and subsurface soil sampling events are described in greater detail in *Remedial Investigation/Source Control Evaluation Report Northwest Pipe Company Portland, Oregon* (CH2M HILL, 2005a) and in *Interim Report Summarizing Additional Soil and Roof Runoff Investigation Results* (CH2M HILL, 2010).

3.1.1 Data Representativeness/Usability

A data usability evaluation was conducted to assess which of the available data represent current site conditions, are suitable for the purpose of risk screening, and can be used to help identify potential data gaps. For the historical data, the usability evaluation was conducted as part of the RI/SCE. The current data, which is included as part of this updated risk screening, was evaluated using a similar process. A determination of adequacy for use in the risk evaluation was made using the following two lines of evaluation:

- Identification of the adequacy of method detection limits (MDLs) for current and historical data to detect potential risks

- Evaluation of the spatial, chemical, and temporal representativeness of the available analytical data, and an assessment of whether these data are relevant to plausible exposure pathways at the facility

For the first step, MDLs for these data were compared against applicable DEQ risk-based concentrations (RBCs) (for example, occupational-worker RBCs).

For the second step, site data were evaluated to determine whether they were representative of potential exposures possible for Northwest Pipe Company. The criteria for data representativeness are defined as follows:

- **Chemical representativeness**—identifies whether analyses were conducted for constituents expected to be present, based on an understanding of historical processes or practices and potential releases at the site

- **Exposure representativeness**—identifies whether environmental media were evaluated where receptor exposure is most feasible (for example, the surface soil horizon)

- **Spatial representativeness**—identifies whether samples were collected with sufficient density and areal coverage so that the detected constituent concentrations represent a geographically integrated exposure for the receptors of concern

- **Temporal representativeness**—identifies whether samples were collected within a timeframe such that detected constituent concentrations reasonably indicate current site conditions

3.1.2 Data Usability Conclusions

Considering the criteria presented in Section 3.1.1, the following conclusions are drawn:

- MDLs for the data set are below DEQ RBCs for occupational workers.
- Older data (1988 and 1989) from additional historic source areas were not included in the risk screening. These older data are no longer representative of current conditions because of remedial actions that occurred after those samples were collected.
- 2001 and 2005 soil data - These investigations at the site were focused on areas where historic activities may have contributed constituents to soil.
- 2006 and 2007 - These investigations focused beyond areas of suspected historic releases and provide a more comprehensive understanding of site surface soil conditions.
- 2008 and 2009 soil data – These data are considered most representative of current and future site conditions, and MDLs were below applicable human health benchmarks. As with the historical data, many of the sample locations were focused at areas of historical activities that may have contributed constituents to soil.

3.2 Conceptual Site Exposure Model

The conceptual site exposure model (CEM) was developed for the site during the RI/SCE investigation (CH2M HILL 2005a). The CEM was developed using regulatory guidance and professional judgment, combined with information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the site to identify potentially complete human and ecological exposure pathways. This updated RSE focuses on the human health exposures to COIs in soil. The routes of exposure considered in this screening RSE are those boldfaced in Figure 3.

3.2.1 Contaminant Sources and Release Mechanisms

The potential COI sources at the site include historical leaks and spills related to ship yard activities, historical used oil storage by prior and present owners and operators, historical coal tar enamel storage and use, historical transformer operations, and offsite sources including transport of offsite soil onsite and fugitive dust. The primary COIs identified at the Northwest Pipe property include PAHs, PCBs, metals, and solvents.

3.2.2 Potentially Complete Ecological Exposure Pathways and Receptors

The Level I Scoping Assessment (CH2M HILL 2005b) indicated that the Northwest Pipe site and surrounding properties are highly ruderal and developed, minimizing the likelihood that wildlife will reside or forage onsite. Therefore, no complete ecological exposure pathways were identified for onsite soil.

3.2.3 Potentially Complete Human Exposure Pathways and Receptors

Based on current understanding of land use at or near the site, the most plausible exposure settings considered for characterizing human health risks are described as follows.

3.2.3.1 Onsite Occupational Worker Scenario

The most feasible population potentially exposed to surface soil at property includes current and future occupational workers. However, it is unlikely that occupational workers would be significantly exposed to surface soil because the majority of the site is paved. Although occupational exposures to soil are limited, this scenario is evaluated to provide a conservative screening for surface soil.

Potential routes of exposure to surface soil [0 to 3 feet below ground surface (bgs)] for the onsite industrial worker include incidental soil ingestion, dermal contact with soil, and inhalation of ambient vapors or dust generated from wind.

3.2.3.2 Future Onsite Construction and Excavation Worker Scenarios

The most feasible population potentially exposed subsurface soil (0 to 15 feet bgs) at the site under reasonably anticipated site use conditions includes future construction and excavation workers, during repair or placement of utilities, and so on.

Potential routes of exposure to surface soil for the onsite construction and excavation workers include incidental soil ingestion, dermal contact with soil, and inhalation of ambient vapors or dust generated from excavation activities.

3.3 Risk Screening Evaluation

This section provides the results of the screening human health risk evaluation. The objectives are (1) to complete a screening risk evaluation in accordance with OAR 340-122-080(5), (2) to identify the potential for human health exposures to site-related chemicals, and (3) to identify the likelihood of adverse impacts on potential receptors.

This screening risk evaluation was conducted using a phased (tiered) approach. The results of a given tier are used to determine which of the following recommendations can be made:

- No further investigations at the site
- Continuation of the risk assessment process at the next level
- Undertake an interim or final remedial action

3.3.1 Human Health Risk Screening

This section presents the human health risk screening for the Northwest Pipe property.

The overall objectives of the human health risk screening are (1) to identify the potential for human health exposures to site-related COIs and (2) to identify the likelihood of adverse impacts on potential receptors. This risk evaluation focuses on the potentially complete human exposure pathways identified in the CEM (Section 3.2).

3.3.1.1 Phase 1 Human Health Risk Screening Methodology

The following conservative screening benchmarks are used for the human health risk screening to determine the potential for risk from COIs:

- For the evaluation of potential exposures to current and future onsite occupational workers at Northwest Pipe property, data from surface soil were directly compared with the following RBCs for occupational workers: soil ingestion, dermal contact, inhalation, and volatilization to outdoor and indoor air (DEQ, 2009). When a DEQ

RBC was unavailable, U.S. Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) for industrial workers (EPA, 2009) were included in the screening.[1]

- For the evaluation of potential exposures to future onsite construction and excavation workers at the Northwest Pipe property, data from surface and subsurface soil were directly compared with DEQ soil ingestion, dermal contact, and inhalation RBCs for excavation workers (DEQ, 2009).

The results from each individual sample are compared to respective screening benchmarks for each COI. Areal averaging of sample data was not used.

3.3.1.2 Human Health Risk Screening Results

The results of the risk screening evaluation are provided in this section. COIs that exceed human health soil RBCs are carried forward for further analysis in Section 3.3.1.3.

Onsite Occupational Worker Scenario

Soil ingestion, dermal contact, and inhalation. Data from individual surface soil samples collected from Northwest Pipe are compared to DEQ RBCs for occupational workers. The results of this comparison are provided in Table 1. The following COIs were detected in surface soil samples at levels exceeding the RBCs for occupational workers:

- Arsenic
- Chromium
- PAHs
- PCBs

Volatilization to outdoor (ambient) and indoor air. Data from individual surface and subsurface soil samples collected from the Northwest Pipe facility were compared to DEQ RBCs for occupational worker exposure to vapors in outdoor and indoor air. The results are provided in Tables 1 and 2. Concentrations of COIs detected in surface soil samples did not exceed the RBCs for occupational workers.

Future Onsite Construction Worker Scenario

Soil ingestion, dermal contact, and inhalation. Data from individual soil samples collected from Northwest Pipe are compared to DEQ RBCs for construction workers. The results of this comparison are provided in Tables 1 and 2. The following COIs detected in soil samples exceeded the RBCs for construction workers:

<u>Surface Soil</u>

- Arsenic
- Chromium
- PAHs
- PCBs

---

[1] The DEQ RBCs and EPA RSLs were calculated to equate with a target cancer risk of 1 x 10^{-6} or a hazard quotient of 0.1 for carcinogenic and non-carcinogenic COIs, respectively. Therefore, achieving these concentrations infers acceptable cumulative risk, in accordance with DEQ guidance.

Is should be noted that maximum concentrations of all constituents detected in subsurface soil (Table 2; 3 to 15 feet bgs) were below their respective construction worker RBCs.

Future Onsite Excavation Worker Scenario

Excavation workers may be exposed to COIs detected in both surface and subsurface soil samples. Surface and subsurface soil data collected from Northwest Pipe were compared with DEQ excavation worker RBCs (DEQ, 2009). The results are provided in Tables 1 and 2. Maximum concentrations of all constituents detected in surface and subsurface soil were below their respective excavation-worker RBCs. Therefore, no further evaluation of this pathway is necessary.

3.3.1.3 Significance of Risk Screening Exceedances

The human health screening was intended to be a conservative screening tool that uses intentionally conservative assumptions to evaluate potential cumulative effects from exposure to multiple COIs in soil. This section describes the significance of the screening exceedances by considering more realistic exposure assumptions and background concentrations for inorganic constituents.

Onsite Occupational Worker Scenario

Arsenic. Arsenic concentrations exceeding screening values were detected in all surface samples collected in 2009, with the exception of SS-409. The DEQ default background concentration for arsenic is 7 milligrams per kilogram (mg/kg) (DEQ, 2007), also above the occupational worker RBC. Four of the 11 sample locations had arsenic levels above 7 mg/kg: 7.2, 7.8, 10.6, and 31 mg/kg. Only one of the 11 sample locations (SS-410) had an arsenic concentration greater than twice the background concentration, a value DEQ has identified as a screening value in the Joint Source Control Strategy (DEQ 2007). This sample, SS-410, was collected from a small area of soil near the plant entrance that was paved in October 2009 as an interim remedial source control measure.

Chromium. Chromium concentrations exceeding screening values were detected in five surface sample locations sampled in 2009. The highest concentrations of chromium were detected at SS-405 and SS-407, where concentrations exceeded the occupational RBC by factors of 124 and 190, respectively. These samples were collected in areas that were subsequently capped with pavement after DEQ approval in 2009, eliminating direct exposure in this area. It should also be noted that the RBC is based on the toxicity factors for hexavalent chromium. Although chromium speciation was not analyzed, most (if not all) chromium measured at the site is expected to be in the less toxic trivalent form as a hexavalent chromium source is not known to have existed at this site. Hence, the potential risk would be significantly lower than implied by using the hexavalent chromium RBC. That is, the chromium concentrations at the site are well below applicable trivalent chromium RBCs.

PAHs. PAH concentrations exceeding screening values were detected in surface soil in 6 sample locations sampled in 2009, 1 sample locations sampled in 2008, and 16 locations sampled in 2006-2007. The highest concentrations of PAH compounds were detected at SS-321, which is located in an unpaved area; exposure to this area under normal occupational activities is plausible. Occupational RBCs are exceeded at two locations (SS-321 and SS-411) more than 100-fold for benzo(a)pyrene.

PCBs. Total PCB concentrations exceeded screening values at three locations in 2008-2009 (TP-1, SS-409, and SS-411) and 9 locations sampled 2006-2007 (SS-5, SS-8, and SS-13 in 2006; SS-305, SS-306, SS-307, SS-309, SS-310, and SS-312 in 2007). Aroclor 1254 and 1260 were the PCBs detected above screening level values. Maximum factors of exceedances for Aroclor 1254 in historical and 2009 samples are 15 and 12, respectively. The maximum factor of exceedances for Aroclor 1260 in historical samples is 2, with no exceedances in 2009.

Potential Future Construction Worker Scenario

Arsenic. Arsenic concentrations exceeding screening values for the construction worker scenario were detected in two surface samples collected in 2009 (SS-410 and SS-411). Both of these samples were above the background concentration of 7 mg/kg: 31.5 mg/kg and 10.6 mg/kg, respectively. The small area of soil where SS-410 was collected was paved in October 2009, as a result exposure in this areas is unlikely.

Chromium. Chromium concentrations exceeding screening values for the construction worker scenario were detected in four surface sample locations sampled in 2009. The highest concentrations of chromium were detected at SS-405 and SS-407, where concentrations exceeded the construction worker RBC by factors of 5 and 8, respectively. As noted above, the RBC is based on the toxicity of hexavalent chromium, which unlikely to be the form present at the site. Additionally, exposure to soils in this area is not expected because these areas were paved following DEQ approval in 2009.

PAHs. PAH concentrations exceeding screening values were detected in surface soil in one location sampled in 2009 and 10 locations sampled in 2006-2007. Construction workers RBCs are exceeded at two locations (SS-321 and SS-411) by more than 25-fold for benzo(a)pyrene. The highest concentrations of PAH compounds were detected at SS-321, which is located in an unpaved area; exposure to this area under normal occupational activities is plausible.

PCBs. Total PCB concentrations exceeded screening values in surface soil at one location in 2009 (SS-409), 4 locations sampled in 2006-2007 (SS-05 and SS-13 in 2006; SS-306 and SS-307 in 2007), and one location in 2001 (SS2).

3.4 Uncertainties and Assumptions with the Risk Evaluations

Uncertainties in screening level risk assessment methods may result in either understating or overstating the ecological risks. The latter is likely considering the highly conservative nature of the screening level risk assessments are intended to be highly conservative. In general, risk estimates are subject to uncertainty from a variety of sources, including the following:

- Sampling, analysis, and data evaluation
- Fate and transport estimation
- Exposure estimation
- Toxicological data

3.4.1 Sampling, Analysis, and Data Evaluation

Uncertainty associated with sampling and analysis includes the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. The quality assurance/quality control (QA/QC) program used in the investigation serves to reduce these errors, but cannot eliminate all errors. The degree to which sample collection and analyses reflect real exposure point concentrations (EPCs) partly determines the reliability of the risk estimates. Sample data used for screening in the RSE were generated from samples collected near suspected source areas or in areas nearly inaccessible under current conditions, rather than the most plausible human and ecological exposure points.

Because exposure is not likely to be limited solely to these potentially higher concentration areas, risk estimates are likely to be conservatively high. As the majority of the site contains paved areas and structures, exposure to soil is limited. This risk evaluation assumes that site workers are exposed daily to chemicals in soil that were generally not collected in high-use areas. As a result, the risk screening for these workers overestimates exposure.

3.4.2 Fate and Transport

These screening risk evaluations make simplifying assumptions about environmental fate and transport of COIs: specifically, that no chemical loss or transformation has occurred. This assumption is reasonable for PCBs because of their tendency to adhere strongly to soil and their limited potential for biodegradation. This assumption is conservative for PAHs, because, while PAHs also adhere strongly to soil, they are known to biodegrade slowly over time. Because of this, the EPCs used for screening could be too high.

3.4.3 Exposure

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, the concentration of COIs at exposure points, and the time period of exposure. Exposure parameters selected to develop screening values are intended to be conservative and likely overstate the actual risks to humans at the Northwest Pipe property.

3.4.4 Toxicological Data

Uncertainties in toxicological data can also influence the reliability of risk management decisions. The usefulness of existing toxicity information in assessing human health and ecological impacts is constrained by several factors. Most toxicity information is generated by laboratory studies with selected test species. The screening values used for this assessment have varying levels of confidence that will affect the usefulness of the resulting risk estimates. Because some of the constituents detected in site media did not have available toxicity screening values on which to quantify risks, these constituents could not be evaluated, which could understate the cumulative risk. However, most of the constituents that have no screening values are generally considered less toxic, because most of the toxicological literature focuses on those constituents considered to be more toxic to human and ecological receptors.

3.5 Conclusions of the Human Health Risk Screening

This human health risk screening for the Northwest Pipe property was conducted in accordance with DEQ approaches (ODEQ, 1998a and (OAR) 340-122-080(5)). This RSE provided sample-specific comparisons of soil data with risk-based screening level values. That is, maximum detected COI concentrations are used, rather than aggregating samples for statistical analysis. Considering this, the RSE is not expected to underestimate exposure and likely overstates the actual risk to current and future workers. Considering the screening results and uncertainties and assumptions, the following conclusions can be made:

- COI concentrations in surface soil at a subset of the sampled locations are high enough in some areas to exceed risk-based screening levels based on occupational and potential future construction workers if the soil becomes accessible to direct contact, but direct contact is unlikely at most of these areas.
- COI concentrations in surface and subsurface soil are not high enough to pose an unacceptable risk to occupational workers by volatilization to outdoor or indoor air.
- COI concentrations in surface and subsurface soil are not high enough to pose an unacceptable risk to potential future excavation workers.

3.6 Hot Spot Evaluation

For the purposes of evaluating surface soil at the Northwest Pipe facility, a “hot spot” concentration is a term defined by OAR 240-122-115(32)(b) as soil with concentrations of hazardous substances posing an excess risk to human or ecological receptors such that the concentration is:

- 100 times the acceptable risk level for human exposure to each individual carcinogen
- 10 times the acceptable risk level for human exposure to each individual noncarcinogen

Hot spot values are presented in Table 3 for surface soil, considering human exposure pathways.

The results of the inorganic constituent analysis for surface soil identified no highly concentrated hot spots for inorganic constituents.

For benzo(a)pyrene, the hot spot screening levels are 21 mg/kg for an industrial worker, 27 mg/kg for an occupational worker, and 210 mg/kg for a construction worker. One sample location from the most recent data set (SS411—located on leased property, on the south end of the facility next to an offsite rail line) and one sample from the 2007 data set (SS321—located on a narrow strip of soil at the north end of the lining and coating building) had concentrations of benzo(a)pyrene that exceeded the occupational worker hot spot screening level: SS411 at 29.75 mg/kg and SS321 at 38.2 mg/kg. Sample location SS321, which is bounded by pavement and other samples that showed substantially lower PAH concentrations, was collected from north of the lining and coating area, near where coal tar enamel product historically was stored prior to use in lining potable water pipes in accordance with American Water Works Association (AWWA) standard C203 (AWWA, 2010).

The facility has not used coal tar enamel to coat pipes since 2008. Sample SS411 was collected at the southern edge of the site from soil that had eroded and sloughed onto pavement on the property leased by Northwest Pipe Company from the elevated land that runs along the southern boundary of this leased land. This elevated land includes a rail line and North Terminal Road, where scrap metal delivery trucks and bins associated with the International Terminals scrap yard operation are routinely parked.

None of the PCB Aroclor concentrations constitutes a highly concentrated hot spot for industrial worker exposure because none exceeded a value of 74 mg/kg, which is 100 times the industrial worker RSL for Aroclors 1254 and 1260, based on cancer risk (EPA 2009).

4.0 Remedial Action Objectives

Remedial action objectives (RAOs) define the expectations of the proposed interim remedial action and are based on the protection of human health, considering the results of the RSE. Additionally, the selected interim remedial action must be consistent to the planned future use of the property: continued operation as an industrial facility. The RAOs for surface soil are:

- Preventing human exposure through direct contact with soil containing PAHs and/or PCBs at concentrations that exceed acceptable risk levels
- Minimizing transport of soil from erosion (by wind or water) to prevent inhalation of affected soil and to achieve source control for storm water
- Treating, removing, or encapsulating identified hot spots in surface soil, to achieve acceptable risk levels for potential receptors (industrial workers)

General response actions describe those actions that will satisfy the RAOs. General response actions considered for those areas posing human health risks included:

- **No Action**. A "no action alternative" serves as a baseline for comparison of other potential remedial actions.
- **Use Restrictions with Engineering/Institutional Controls**. Engineering and institutional controls are physical measures and land use restrictions that prevent or minimize exposure and access to surface soil.
- **Soil Treatment**. Treatment intended to remove the constituents of concern from the surface soil.
- **Soil Capping.** Covering the affected surface soil with pavement to control direct contact by humans, and to eliminate potential soil erosion by stormwater or wind.
- **Excavation /Offsite Disposal**. Removal, transportation, and offsite disposal removes affected surface soil from the site and places the material in a permitted facility that isolates the material from contact with the environment.
- **Erosion Control Best Management Practices (BMPs)**. Installing perimeter control devices to prevent offsite contaminated soil from sloughing onto the site.

Site stormwater drainage projects are currently in the planning phase for future implementation at the site. These stormwater drainage projects could potentially include trenching for installation of new stormwater conveyance lines and collection points (catch basins). The focus of the FFS is on surface soil, and does not take into account future stormwater improvements. For the purpose of developing and selecting interim actions, the stormwater conveyance improvements, if any, will be assumed to be complete prior to implementing the interim action.

5.0 Remedial Technologies Screening and Development

The following steps were used to develop the interim remediation technologies:

1. Identify general response actions as described in the *Guidance for Conducting Feasibility Studies* (DEQ 1998b).
2. Identify supporting technologies needed to implement each general response action.
3. Screen technologies to eliminate those that:
   - Are clearly inappropriate for the site,
   - Do not meet the criteria for effectiveness and implementability as described in OAR 340-122-090, or
   - Have implementation costs disproportionate to other technologies having similar benefit with respect to risk reduction.

The results of the screening evaluation are presented in Table 4, which summarizes the rationale for retention/exclusion of each technology from further consideration as a potential interim remedial alternative.

The initial screening of surface soil interim remediation technologies led CH2M HILL to retain the no action remedy and the following technologies:

- Use restrictions through easement and deed restrictions
- Capping
- Removal with offsite disposal
- Erosion control best management practices

Remedial alternative descriptions are presented below.

5.1.1 Alternative 1—No Action

The "no action" alternative is evaluated under the assumption that areas of surface soil contamination are not remediated using standard engineering practices.

5.1.2 Alternative 2— Excavation and Asphalt Capping

Alternative 2 consists of excavating and removing the soil to a depth of 2 feet below grade within the remedial target area (shown in Figure 4) and capping the target area with "clean fill" and a minimum of four inches of asphaltic concrete. The subgrade of the asphalt will consist of a minimum of 6 inches of Class II aggregate base course. The base course will be compacted. The asphalt cap will be placed in accordance with industry standards and will consist of two separate 2" lifts to obtain uniform compaction. The asphalt will be hot rolled, with the first lift compacted using a roller (minimum of one time). The second lift will be compacted with a roller multiple times. A more detailed description of cap specifications will be provided to DEQ in the future.

The schematic for the asphalt placement is presented in Figure 5. Soil removed from the site under Alternative 2 would be disposed at a permitted solid waste landfill.

It is assumed that a pavement cap would be necessary, even with soil removal, because the screening concentrations in DEQ's Joint Source Control Strategy guidance document are so low that a quantitative demonstration of source control would be unlikely even with placement of "clean fill" derived from commercially obtained backfill (considering the inorganic constituents that occur naturally in soil).

Under this alternative, aggregate obtained from a commercial aggregate supplier will be used as a base course beneath the asphalt cap. In addition, an erosional control fence will be installed along portions of the southern boundary of the leased property to reduce the potential for offsite soil to slough onto the property in the future. The resulting asphalt cap and soil removal will sufficiently prevent exposure of the surface soil for industrial worker exposures, and the erosion control fence would prevent soil from mobilizing onto paved areas in the southern portion of the property. During soil removal and capping activities, numerous Best Management Practices (BMPs) would be utilized to minimize erosion and prevent sedimentation from leaving the construction site. The BMPs will be outlined in the erosion and sediment control plan (ESCP) that will be submitted to DEQ as part of the NPDES General Permit 1200-C application. The minimum anticipated BMPs for this project would include; dust suppression, stockpile management consisting of covering stockpiles with plastic sheeting, perimeter control of disturbed soils with the use of silt fence or compost berms, and a truck tire wheel wash to prevent sediment from being tracked offsite. In addition, the BMPs will be inspected, maintained, and upgraded as warranted to prevent erosion and sedimentation.

The excavation and disposal of contaminated soil and placement of an asphalt cap would prevent direct contact with the affected soil and eliminate the possibility of transport by wind and storm water erosion during construction and after the cap is in place. This alternative therefore meets the RAOs.

5.1.3 Alternative 3— Asphalt Capping with Use Restriction

Alternative 3 consists of capping the target area (shown in Figure 4) with a minimum of four inches of asphaltic concrete (Figure 5). The asphalt will be installed as described in the previous Alternative. Prior to applying pavement, the area to be paved will be graded until it is within approximately four inches of existing nearby pavement. In general, grading will consist of scraping soil from areas of higher elevation and smoothing it over areas of lower elevation until a consistent grade, with positive drainage is achieved. The asphalt cap will be placed in two separate 2" lifts to obtain uniform compaction. During surface preparation and capping activities, numerous Best Management Practices (BMPs) would be utilized to minimize erosion and prevent sedimentation from leaving the construction site. The BMPs will be outlined in the erosion and sediment control plan (ESCP) that will be submitted to the City of Portland as part of the NPDES General Permit 1200-C application. The minimum anticipated BMPs for this project would include; dust suppression, stockpile management consisting of covering stockpiles with plastic sheeting, and perimeter control of disturbed soils with the use of silt fence or compost berms. In addition, the BMPs will be inspected, maintained, and upgraded as warranted to prevent erosion and sedimentation.

If necessary, aggregate obtained from a commercial aggregate supplier will be used to achieve desired grade. In addition, an erosional control fence will be installed along portions of the southern boundary of the leased property to reduce the potential for offsite soil to slough onto the property in the future. The resulting asphalt cap will be sufficiently thick to prevent exposure of the surface soil for industrial worker exposures, and the erosion control fence would reduce the potential for offsite soil to slough onto the site.

To prevent the possibility of contact with capped soil left in place, an easement and equitable servitude with deed restrictions would be implemented for the property. A contaminated media management plan (CMMP) will also be developed and maintained.

The placement of the asphalt cap would prevent direct contact with affected soil and eliminate the possibility of transport by wind and storm water erosion during construction and after the cap is in place. The cap will be inspected annually for integrity. During the inspections the cap will be visually inspected for cracks, rutting, or signs of deterioration. If significant cracks, which could lead to accelerated wear and soil exposure are discovered, the cap will be repaired. Asphalt sealant or additional placement of asphalt will be evaluated during the cap inspection, and if warranted, will be initiated on an as required basis. A summary report will be prepared on an agreed-upon frequency documenting the condition of the cap and any necessary repairs and submitted to DEQ. This alternative therefore meets the RAOs.

5.1.4 Alternative 4— Hot Spot Excavation and Asphalt Capping with Use Restriction

Alternative 4 consists of excavating and removing the surface soil (0 to 2 feet below grade or to the top of underlying pavement) in the two localized areas where hot spot screening levels were exceeded (Figure 6), followed by capping the unpaved portions of the target remedial area with a minimum of four inches of asphaltic concrete (Figure 5). The asphalt will be installed as described in the previous alternatives. The asphalt cap will be placed in two separate 2-inch lifts to obtain uniform compaction. Hot spot soil excavation will focus on surface soil (0 to 1 foot deep, based on previous sampling results) and will involve the areas depicted as hot spot removal areas on Figure 5. After hot spot removal in the northern area near the lining and coating building, confirmation soil samples will be collected at the bottom of the excavation area (two samples randomly located) and at the perimeter (four samples; one on each edge) to confirm that soil with hot spot-level concentrations has been removed. No confirmation sampling will be conducted on the southern area because this hot spot consists of offsite soil that has sloughed onto pavement on the site from elevated ground to the south. During soil removal and capping activities, numerous Best Management Practices (BMPs) will be used to minimize erosion and potential suspended sediment transport from the construction site. The BMPs will be outlined in the erosion and sediment control plan (ESCP) that will be submitted to DEQ as part of the NPDES General Permit 1200-C application. The minimum anticipated BMPs for this project would include; dust suppression, stockpile management consisting of covering stockpiles with plastic sheeting, perimeter control of disturbed soils with the use of silt fence or compost berms, and a truck tire wheel wash to prevent sediment from being tracked offsite. In addition, the BMPs will be inspected, maintained, and upgraded as warranted to prevent erosion and sedimentation.

Following hot spot removal, the area will be graded until it is within approximately four inches of existing nearby pavement. In general, grading will consist of scraping soil from areas of higher elevation and smoothing it over areas of lower elevation until a consistent grade is achieved. If necessary, aggregate obtained from a commercial aggregate supplier will be used where necessary to achieve desired grade prior paving. The resulting asphalt cap and soil removal will sufficiently prevent exposure to the surface soil by industrial workers. In addition, an erosional control fence will be installed along portions of the southern boundary of the leased property to reduce the potential for offsite soil to slough onto the property in the future.

To prevent the possibility of contact with capped soil left in place, an easement and equitable servitude with deed restrictions are required for the property. A CMMP will also be developed and maintained.

The excavation of contaminated soil and placement of the asphalt cap would prevent direct contact (ingestion, inhalation, or dermal) with affected soil and eliminate the possibility of transport via wind and storm water erosion during construction, as well as when the asphalt cap is in place. The integrity of the cap will be inspected on an annual basis for the first five years, and once every five years for the following fifteen years. During the inspections the cap will be visually inspected for cracks, rutting, or signs of deterioration. If significant cracks, which could lead to accelerated wear and soil exposure are discovered, the cap will be repaired. Asphalt sealant or additional placement of asphalt will be evaluated during the cap inspection, and if warranted, will be initiated on an as required basis. A summary report will be prepared documenting the condition of the cap and any necessary repairs and submitted to DEQ. This alternative therefore meets the RAOs.

6.0 Evaluation of Remedial Alternatives

The remedial action alternatives were evaluated based on the seven criteria described in the Oregon Administrative Rules for feasibility studies as described in OAR 340-122-085:

- Protectiveness
- Effectiveness
- Long-term reliability
- Implementability
- Implementation risk
- Reasonableness of cost
- Treatment of hot spots

Table 5 compares the four alternatives based on these criteria. OAR 340-122-090(4)(c) states:

> "The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management."

Alternatives were evaluated individually according to DEQ criteria listed above and summarized below. Cost estimates for each alternative are summarized in Table 6 and presented in greater depth in Tables 7 through 9. Consequential costs to Northwest

Pipe's plant for implementing the interim remedial alternative, resulting from such activities as moving pipe associated with site preparation or potential interruptions to plant operations are not included in these estimates. Although these costs are likely to be substantial, they would be similar for all active remedies and would not affect the relative cost ranking of the alternatives considered.

6.1 Alternative 1—No Action

The no action alternative was carried through as a baseline against which other alternatives can be compared. A "no action" alternative is not protective of potential human receptors because potential future exposure to contaminated surface soil would not be addressed.

6.2 Alternative 2— Excavation and Asphalt Capping

Alternative 2, removal and offsite disposal of surface soil, and placement of an asphalt cap, is protective because contaminated material would be removed from the site, and residual risk would be minimized with the placement of the asphalt cap. The excavated soil would be disposed of in a permitted disposal facility. The hot spot soil areas are treated in this alternative by excavation and disposal.

The overall effectiveness and long-term reliability of this alternative are higher than under Alternatives 3 and 4 because the material would no longer remain onsite. Ease of implementation is lower than under Alternatives 3 and 4, as is duration, due to the complexity of doing a large excavation project at an operating industrial facility that already faces significant space constraints even without the interference from excavation activities. In addition, a Site Development Permit would be required from the City of Portland. As part of the Site Development Permit, a Grading Plan, Stormwater Report, Erosion and Sediment Control Plan, and possibly a Utility Plan (if storm water system modifications are necessary) would need to be approved by the City of Portland. The erosion and Sediment Control Plan will also be submitted to DEQ to obtain a NPDES General 1200-C for construction stormwater. Implementation risk is higher than under Alternatives 3 and 4 due to the greater volume of material being transported over public roadways during implementation. The unquantifiable cost for economic harm to plant operations also would be higher than under Alternatives 3 and 4.

This alternative involves the most capital cost, estimated at $4,472,600. This cost is approximately twice than under Alternative 3 or 4. Alternative 2 achieves the highest level of effectiveness and long-term reliability. Table 7 presents the cost estimate summary for Alternative 2.

6.3 Alternative 3— Asphalt Capping with Use Restriction

Alternative 3, constructing an asphalt cap over exposed soil, is protective because the exposure pathways to the affected soil would be eliminated. The surface soil would remain onsite, and only the hot spot consisting of sloughed soil onto the south edge of the facility would be treated.

The overall effectiveness and long-term reliability of this alternative are lower than under Alternatives 2 and 4, because no material would be removed other than the sloughed soil. Ease of implementation is higher than under Alternative 2 and

Alternative 4 because less disposal would be required under Alternative 3. In addition, a Site Development Permit would be required from the City of Portland. As part of the Site Development Permit, a Grading Plan, Stormwater Report, Erosion and Sediment Control Plan, and possibly a Utility Plan (if storm water system modifications are necessary) would need to be approved by the City of Portland. The erosion and Sediment Control Plan will also be submitted to DEQ to obtain a NPDES General 1200-C for construction stormwater. Implementation risk is lower than under Alternatives 2 and 4 due to less material being transported over public roadways during implementation.

Aside from the "No Action Alternative", this alternative involves the least capital cost, with an estimated cost of $1,756,638. Alternative 3 achieves the lowest level of effectiveness and long-term reliability. Table 8 presents the cost estimate summary for Alternative 3.

6.4 Alternative 4— Hot Spot Excavation and Asphalt Capping with Use Restriction

Alternative 2, removal and offsite disposal of hot spot surface soil followed by construction of an asphalt cap, is protective because soil exceeding the hot spot screening levels would be removed from the site, and residual risk would be minimized with the placement of the asphalt cap. The excavated soil would be disposed of in a permitted disposal facility. The hot spot soil areas are treated in this alternative by excavation and disposal.

The overall effectiveness and long-term reliability of this alternative are higher than under Alternative 3, because both of the hot spots would be removed. Ease of implementation is higher than under Alternative 2 and lower than under Alternative 3. In addition, a Site Development Permit would be required from the City of Portland. As part of the Site Development Permit, a Grading Plan, Stormwater Report, Erosion and Sediment Control Plan, and possibly a Utility Plan (if storm water system modifications are necessary) would need to be approved by the City of Portland. The erosion and Sediment Control Plan will also be submitted to DEQ to obtain a NPDES General 1200-C for construction stormwater. Implementation risk is higher than under Alternative 3 due to more material being transported over public roadways during implementation.

This alternative involves a slightly higher capital cost than Alternative 3 (by about $181,000), with an estimated cost of $1,937,914. Alternative 4 achieves the second highest level of effectiveness and long-term reliability. Table 9 presents the cost estimate summary for Alternative 4.

7.0 Recommended Interim Remedial Alternative

Based on the qualitative and quantitative evaluations of the interim remedial alternatives, the recommended alternative is Alternative 4, hot spot soil removal and placement of a cap. This alternative meets the protectiveness standard for remedial actions. Alternative 4 has a similar, but slightly lower effectiveness and long-term reliability compared with Alternative 2, but its cost is substantially less. Alternative 3 is the lowest-cost alternative, but does not reduce the volume of surface soil or provide removal of the hot spots. The high cost of Alternative 2 does not provide proportional benefit in terms of reliability or long-term effectiveness. Alternative 2 would also cause the greatest disruption to plant operations due to the invasiveness of a large-scale excavation, backfill, and paving project. Consequently, Alternative 2 fails a disproportionate cost evaluation relative to Alternative 4.

8.0 References

American Water Works Association (AWWA). 2010. *Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied*. AWWA/ANSI Standard C203-08.

CH2M HILL 2010. *Interim Repot Summarizing Additional Soil and Roof Runoff Investigation Results.* Provided to Jim Orr of Oregon Department of Environmental Quality in April 2010.

CH2M HILL. 2008. *Supplemental Site Characterization Results, Northwest Pipe Company, Portland, Oregon.* Unbound maps, tables, and digital laboratory reports generated during the period 2006 to 2008. Provided to Jim Orr of Oregon Department of Environmental Quality in September and October 2008.

CH2M HILL. 2005a. *Remedial Investigation / Source Control Evaluation Report Northwest Pipe Company Portland Facility*. Unpublished consultant's report submitted December 2005.

CH2M HILL. 2005b. *Appendix C - Level I Scoping.* Unpublished consultant's report submitted December 2005.

CH2M HILL. 2005c. Sampling and Analysis Plan, Northwest Pipe Company, Portland, Oregon.

CH2M HILL 2001a. Preliminary Assessment Addendum, Northwest Pipe Company, Portland, Oregon. Unpublished consultant's report prepared for submittal to Oregon Department of Environmental Quality. February 2001.

CH2M HILL. 2001b. Technical Memorandum No. 1: Site Investigation Report, Northwest Pipe Company. Unpublished consultant's report prepared for submittal to Oregon Department of Environmental Quality. December 5.

CH2M HILL. 2000. Preliminary Assessment Report, Northwest Pipe Company, Portland, Oregon. Unpublished consultant's report prepared for submittal to Oregon Department of Environmental Quality. November.

Crosby & Overton. 1989a. August 11, 1989, Letter from Hubert Willer, Project Manager for Crosby & Overton, to William Dana, Oregon Department of Environmental Quality.

Crosby & Overton. 1989b. Remedial Activities Report, Northwest Pipe and Casing. Unpublished consultant's report.

Dames & Moore. 1989. Phase I and Phase II Property Transfer Assessment, Northwest Pipe and Casing Company Site, Portland, Oregon, for Northwest Pipe and Casing Company. Unpublished consultant's report. March 9, 1989.

Golder Associates, Inc. 1990. Site Investigation and Preliminary Remediation Plan for Portland Stockyards. Unpublished consultant's report.

U.S. Environmental Protection Agency (EPA). 2009. Regional Screening Table, updated December 2009. Accessed at www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm, March 17, 2010.

U.S. Environmental Protection Agency (EPA). Region 6. 2006. Human Health Medium-Specific Screening Levels. http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm, accessed the week of November 6, 2006.

Northwest Pipe Company. 2000. Letter from Carol Grant of Northwest Pipe to Dennis Juries of Oregon Department of Environmental Quality and Brett Hulstrom of the City of Portland. July 14.

Oregon Department of Environmental Quality. 2009. *Risk-Based Decision Making (RBDM) for the Remediation of Petroleum-Contaminated Sites.* www.deq.state.or.us/lq/rbdm.htm, accessed March 17, 2010.

Oregon Department of Environmental Quality. 2007. Table 3-1, Screening Level Values for Soil/Stormwater Sediment, Stormwater, Groundwater, and Surface Water, contained in *Portland Harbor Joint Source Control Strategy*. Updated 7-16-2007.

Oregon Department of Environmental Quality. 2003. Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites. Oregon Department of Environmental Quality Land Cleanup Division Environmental Cleanup and Tanks Program. September 23, 2003.

Oregon Department of Environmental Quality. 1998a. Oregon Department of Environmental Quality, Guidance for Conduct of Deterministic Human Health Risk Assessments, December 1998.

Oregon Department of Environmental Quality. 1998b. Oregon Department of Environmental Quality, Guidance for Conducting Feasibility Studies, July 1.

Oregon Department of Environmental Quality. 1991. Strategy Recommendation for Northwest Pipe and Casing Company. October 31.

Table 1

Risk Screening Results for Chemicals of Interest Detected in Surface Soil

Northwest Pipe Company

Analyte	CAS No.	Basis of Screening Level	DEQ RBC$_{ss}$ [1 8] Occupational	DEQ RBC$_{ss}$ [1 8] Construction Worker	DEQ RBC$_{ss}$ [1 8] Excavation Worker	DEQ RBC$_{SO}$ [2 8] Occupational	DEQ RBC$_{Si}$ [3 8] Occupational	Maximum Detected Value	SS1	SS2	GP50	SS101	SS102	SS103	SS104	SS-01
Station ID									SS1	SS2	GP50	SS101	SS102	SS103	SS104	SS-01
Sample ID									SS10_5091001	SS20_5091001	GP50_5091001	SS101	SS102	SS103	SS104	SS-01-0
Date Sampled									09/10/01	09/10/01	09/10/01	06/21/05	06/21/05	06/21/05	06/21/05	10/04/06
Depth:																
Sample QA Type:									N	N	N	N	N	N	N	N
Inorganics (mg/kg):																
Aluminum	7429-90-5	nc	99,000 [4]	--	--	--	--	27,000								
Antimony	7440-36-0	nc	41 [4]	--	--	--	--	4.0								
Arsenic	7440-38-2	c, nc	1.7	8.5	240	--	--	32								
Cadmium	7440-43-9	nc	50	15	430	--	--	9.0								
Chromium	7440-47-3	nc	19 [7]	480	--	--	--	3,620								
Copper	7440-50-8	nc	4,100	1,200	>max	--	--	255								
Lead	7439-92-1	nc	800	800	800	--	--	195								
Mercury	7439-97-6	nc	31	9.3	260	--	--	0.20								
Nickel	7440-02-0	nc	2,000	610	>max	--	--	519								
Selenium	7782-49-2	nc	510 [4]	--	--	--	--	12								
Silver	7440-22-4	nc	510	150	4,300	--	--	4.0								
Zinc	7440-66-6	nc	31,000 [4]	--	--	--	--	1,400								**31**
Organochlorine Pesticides (mg/kg): [4]																
alpha-BHC	319-84-6	c	0.34	2.6	74	--	--	0.007								
Polynuclear Aromatic Hydrocabons (mg/kg):																
Acenaphthene	83-32-9	nc	6,100	1,900	>max	--	--	3.7								0.0023 U
Acenaphthylene	208-96-8		--	--	--	--	--	0.34								**0.0061**
Anthracene	120-12-7	nc	17,000 [4]	9,300	>max	--	--	19								**0.017**
Benzo (a) anthracene	56-55-3	c	2.7	21	590	--	--	54								**0.04**
Benzo (a) pyrene	50-32-8	c	0.27	2.1	59	--	--	38								**0.052**
Benzo (b) fluoranthene	205-99-2	c	2.7	21	590	--	--	58								**0.073**
Benzo (g,h,i) perylene	191-24-2		--	--	--	--	--	19								**0.037**
Benzo (k) fluoranthene	207-08-9	c	27	210	5,900	--	--	37								**0.027**
Chrysene	218-01-9	c	270	2,100	59,000	--	--	57								**0.061**
Dibenzo (a,h) anthracene	53-70-3	c	0.27	2.1	59	--	--	6.4								**0.0095**
Fluoranthene	206-44-0	nc	2,900	890	>max	--	--	166								**0.065**
Fluorene	86-73-7	nc	4,100	1,200	>max	--	--	3.1								**0.0025**
Indeno (1,2,3-cd) pyrene	193-39-5	c	2.7	21	590	--	--	19								**0.029**
Naphthalene	91-20-3	c, nc	23	74	2,100	27	99	0.6								0.0023 U
Phenanthrene	85-01-8		--	--	--	--	--	61								**0.023**
Pyrene	129-00-0	nc	2,100	670	>max	--	--	175								**0.062**
Total PAHs [5]			--	--	--	--	--	701								**0.50**
Polychlorinated Biphenyls (mg/kg) [6]																
Aroclor-1254	11097-69-1	c	0.74 [4]	--	--	--	--	11	**2.7**	**6.2**		**0.0657**	**0.0535**	**0.607**	**0.148**	0.022 U
Aroclor-1260	11096-82-5	c	0.74 [4]	--	--	--	--	2.3	0.0084 U	0.0081 U		0.0342 U	0.0348 U	**0.139**	**0.0595**	0.022 U
Total PCBs [5]		c, nc	0.98	4.40	120	--	--	13	**2.7**	**6.2**		**0.0657**	**0.0535**	**0.75**	**0.21**	0.022 U
Phthalates (mg/kg):																
Bis(2-ethylhexyl)phthalate	117-81-7	c, nc	150	480	33,000	--	--	3								
Butyl benzyl phthalate	85-68-7	c	910 [4]	--	--	--	--	1								
Di-n-butyl phthalate	84-74-2	nc	6,200 [4]	--	--	--	--	0.380								
Total Petroleum Hydrocarbons (mg/kg)																
Diesel			70,000	23,000	>max	>max	>max	650								4.7 U
VOCs (mg/kg) [6]																
Methylene Chloride	75-09-2		-	--	-	--	--	0.001								
Tetrachloroethene	127-18-4	c	5.1	40	1,100	66	1.6	0.015								
Trichloroethene	79-01-6	c	3.9	43	1,200	4.3	0.13	0.001								

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation September 15, 2009

[2] DEQ Risk Based Concentrations Soil Volatilization to Outdoor Air for Occupational Scenario September 15, 2009

[3] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[4] Environmental Protection Agency Regional Screening Level (RSL) December 2009

[5] Total PAHs and PCBs calculated using sum of detects.

[6] non-detected constituents were not included in this table

[7] Screening level is based on 100% hexavalent chromium

[8] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg/kg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is presented

Table 1

Risk Screening Results for Chemicals of Intere

Northwest Pipe Company

Station ID		SS-02	SS-03	SS-04	SS-05	SS-06	SS-07	SS-08	SS-09	SS-10	SS-11	SS-12	SS-13	SS-14	SS-15	SS-16	SS-17
Sample ID		SS-02-0	SS-03-0	SS-04-0	SS-05-0	SS-06-0	SS-07-0	SS-08-0	SS-09-0	SS-10-0	SS-11-0	SS-12-0	SS-13-0	SS-14-0	SS-15-0	SS-16-0	SS-17-0
Date Sampled		10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06	10/04/06
Depth:																	
Sample QA Type:		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	**CAS No.**																
Inorganics (mg/kg):																	
Aluminum	7429-90-5																
Antimony	7440-36-0																
Arsenic	7440-38-2																
Cadmium	7440-43-9																
Chromium	7440-47-3																
Copper	7440-50-8																
Lead	7439-92-1																
Mercury	7439-97-6																
Nickel	7440-02-0																
Selenium	7782-49-2																
Silver	7440-22-4																
Zinc	7440-66-6	**150**	**260**	**200**	**390**	**240**	**100**	**200**	**140**	**1400**	**150**	**240**	**520**	**75**	**130** 0	**80**	**71**
Organochlorine Pesticides (mg/kg):[4]																	
alpha-BHC	319-84-6																
Polynuclear Aromatic Hydrocabons (mg																	
Acenaphthene	83-32-9				**0.093**			**0.097**	**0.35**				**0.58**		**0.013**		
Acenaphthylene	208-96-8				**0.086**			**0.32**	**0.049**				**0.34**		**0.0084**		
Anthracene	120-12-7				**0.36**			**0.81**	**1**				**1.8**		**0.1**		
Benzo (a) anthracene	56-55-3				**3.7 D**			**8.6 D**	**5.1 D**				**13 D**		**0.3** D		
Benzo (a) pyrene	50-32-8				**2.8 D**			**5 D**	**3.3 D**				**8.9 D**		**0.27 D**		
Benzo (b) fluoranthene	205-99-2				**4.4 D**			**7.4 D**	**5.1 D**				**14 D**		**0.42** D		
Benzo (g,h,i) perylene	191-24-2				**1.6**			**3.7 D**	**2.8 D**				**7.2 D**		**0.25** D		
Benzo (k) fluoranthene	207-08-9				**1.3**			**3** D	**1.4**				**5.1** D		**0.17**		
Chrysene	218-01-9				**4.6 D**			**9.7 D**	**5.2 D**				**15 D**		**0.35** D		
Dibenzo (a,h) anthracene	53-70-3				**0.57**			**0.94**	**0.64**				**1.3**		**0.079**		
Fluoranthene	206-44-0				**4.9 D**			**14 D**	**9.5 D**				**25 D**		**0.44** D		
Fluorene	86-73-7				**0.065** 0				**0.39**				**0.51**		**0.0087**		
Indeno (1,2,3-cd) pyrene	193-39-5				**1.4**			**3 D**	**2.3 D**				**6.2 D**		**0.19 D**		
Naphthalene	91-20-3				**0.046**			**0.084**	**0.072**				**0.14**		**0.0044**		
Phenanthrene	85-01-8				**1.1**			**2.3 D**	**5 D**				**10 D**		**0.13**		
Pyrene	129-00-0				**4.9 D**			**14 D**	**8.2 D**				**22 D**		**0.44** D		
Total PAHs[5]					**31.9**			**73.1**	**50.4 0**				**131.1**		**3.2**		
Polychlorinated Biphenyls (mg/kg)[6]																	
Aroclor-1254	11097-69-1				**3.7**			**2.2**	**0.43**				**11**		**0.63**		
Aroclor-1260	11096-82-5				**1.1**			**0.41**	**0.1**				**1.5**		0.21 U		
Total PCBs[5]					**4.8**			**2.6**	**0.5**				**12.5**		**0.63**		
Phthalates (mg/kg):																	
Bis(2-ethylhexyl)phthalate	117-81-7																
Butyl benzyl phthalate	85-68-7																
Di-n-butyl phthalate	84-74-2																
Total Petroleum Hydrocarbons (mg/kg)																	
Diesel					100 U			**360**	120 U				**270**		**42**		
VOCs (mg/kg)[6]																	
Methylene Chloride	75-09-2																
Tetrachloroethene	127-18-4																
Trichloroethene	79-01-6																

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation for Occupational Scenario September 15, 2009

[2] DEQ Risk Based Concentrations Soil Volatilization to Outdoor Air for Occupational Scenario September 15, 2009

[3] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[4] Environmental Protection Agency Regional Screening Level (RSL) December 2009

[5] Total PAHs and PCBs calculated using sum of detects.

[6] VOC non-detects were removed from this table

[7] Screening level is based on 100% hexavalent chromium

[8] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg/kg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is presented

Table 1

Risk Screening Results for Chemicals of Intere

Northwest Pipe Company

Station ID		SS-18	SS-19	SS301	SS302	SS303	SS304	SS305	SS305	SS306	SS307	SS308	SS309	SS310	SS311	SS312	SS313	SS314
Sample ID		SS-18-0	SS-19-0	SS301-0	SS302-0	SS303-0	SS304-0	SS305-0	SS305-1	SS306-0	SS307-0	SS308-0	SS309-0	SS310-0	SS311-0	SS312-0	SS313-0	SS314-0
Date Sampled		10/04/06	10/04/06	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07
Depth:																		
Sample QA Type:		N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N
Analyte	**CAS No.**																	
Inorganics (mg/kg):																		
Aluminum	7429-90-5																	
Antimony	7440-36-0																	
Arsenic	7440-38-2																	
Cadmium	7440-43-9																	
Chromium	7440-47-3																	
Copper	7440-50-8																	
Lead	7439-92-1																	
Mercury	7439-97-6																	
Nickel	7440-02-0																	
Selenium	7782-49-2																	
Silver	7440-22-4																	
Zinc	7440-66-6	**140**	**300**															
Organochlorine Pesticides (mg/kg):[4]																		
alpha-BHC	319-84-6																	
Polynuclear Aromatic Hydrocabons (mg																		
Acenaphthene	83-32-9	**1.9 D**		**0.00668 J**	**0.00538**		**0.0103**	**0.5**	**0.703**		**0.0821 J**		**0.09**	**0.163**		**2.03**	**0.0193 J**	
Acenaphthylene	208-96-8	**0.33**		**0.00351 J**	**0.00281**		**0.00492**	**0.0646 J**	**0.108 J**		**0.179**		**0.0331 J**	**0.0466 J**		**0.0474 J**	**0.0212 J**	
Anthracene	120-12-7	**10 D**		**0.027**	**0.0138**		**0.0202**	**1.42**	**2.71**		**0.417**		**0.312**	**0.602**		**4.82**	**0.0762 J**	
Benzo (a) anthracene	56-55-3	**34 D**		**0.256**	**0.0878**		**0.0958**	**5.11**	**9**		**2.5**		**1.67**	**2.2**		**9.38**	**0.33**	
Benzo (a) pyrene	50-32-8	**19 D**		**0.246**	**0.0889**		**0.0903**	**3.48**	**6.66**		**2.52**		**1.66**	**1.96**		**7.83**	**0.356**	
Benzo (b) fluoranthene	205-99-2	**31 D**		**0.425**	**0.141**		**0.156**	**5.25**	**9.93**		**4.31**		**2.46**	**2.63**		**9.81**	**0.663**	
Benzo (g,h,i) perylene	191-24-2	**14 D**		**0.219**	**0.0889**		**0.0845**	**2.03**	**4.16**		**2.14**		**1.28**	**1.37**		**4.54**	**0.325**	
Benzo (k) fluoranthene	207-08-9	**12** D		**0.153**	**0.0461**		**0.0512**	**2.11**	**3.35**		**1.62**		**0.937**	**1.27**		**6.53**	**0.248**	
Chrysene	218-01-9	**37 D**		**0.279**	**0.107**		**0.106**	**4.66**	**8.52**		**2.75**		**1.73**	**2.29**		**9.67**	**0.382**	
Dibenzo (a,h) anthracene	53-70-3	**4.7 D**		**0.0399**	**0.0149**		**0.0155**	**0.438**	**0.91**		**0.399**		**0.227**	**0.245**		**1.15**	**0.0541 J**	
Fluoranthene	206-44-0	**59 D**		**0.37**	**0.155**		**0.187**	**12.3**	**23.8**		**3.86**		**3.52**	**5.12**		**33.9**	**0.649**	
Fluorene	86-73-7	**2.4 D**		**0.00602 J**	**0.00386**		**0.0133**	**0.521**	**0.978**		**0.0389 J**		**0.11**	**0.167**		**1.92**	0.00818 U	
Indeno (1,2,3-cd) pyrene	193-39-5	**13 D**		**0.155**	**0.0645**		**0.0598**	**1.51**	**3.19**		**1.57**		**0.885**	**0.983**		**3.25**	**0.241**	
Naphthalene	91-20-3	**0.47**		**0.00363 J**	**0.00284**		**0.0434**	**0.127 J**	**0.156 J**		**0.0679 J**		**0.103**	**0.0501 J**		**0.308 J**	**0.0144 J**	
Phenanthrene	85-01-8	**28 D**		**0.0824**	**0.0562**		**0.105**	**6.66**	**12.3**		**0.936**		**1.34**	**2.32**		**24.8**	**0.257**	
Pyrene	129-00-0	**53 D**		**0.404**	**0.157**		**0.171**	**9.87**	**19.3**		**4.05**		**3.27**	**4.69**		**28.2**	**0.623**	
Total PAHs[5]		**319.8**		**2.7**	**1.0**		**1.2**	**56.1**	**105.8**		**27.4**		**19.6**	**26.1**		**148.2**	**4.3**	
Polychlorinated Biphenyls (mg/kg)[6]																		
Aroclor-1254	11097-69-1	**0.94**					**0.0906**	**0.768**	**0.778**	**8.93**	**7.36**		**2.9**	**3.31**		**2.73**	**0.186**	
Aroclor-1260	11096-82-5	0.21 U					0.0248 U	**0.263**	**0.346**	2.34 U	**0.888**		**1.36**	0.489 U		0.49 U	**0.0363**	
Total PCBs[5]		**0.94**					**0.09**	**1.03**	**1.12**	**8.93**	**8.25**		**4.26**	**3.31**		**2.73**	**0.22**	
Phthalates (mg/kg):																		
Bis(2-ethylhexyl)phthalate	117-81-7																	
Butyl benzyl phthalate	85-68-7																	
Di-n-butyl phthalate	84-74-2																	
Total Petroleum Hydrocarbons (mg/kg)																		
Diesel		**650**		**12.3 J**	**11.1 J**	**7.6 J**	**11.3 J**	**224 J**	**169 J**	**276 J**	**96.4 J**	**44.5 J**	**76.9 J**	**50.1 J**	**44.5 J**	**64.6 J**	**25.3 J**	**26.5 J**
VOCs (mg/kg)[6]																		
Methylene Chloride	75-09-2																	
Tetrachloroethene	127-18-4																	
Trichloroethene	79-01-6																	

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation for Occupational Scenario September 15, 2009

[2] DEQ Risk Based Concentrations Soil Volatilization to Outdoor Air for Occupational Scenario September 15, 2009

[3] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[4] Environmental Protection Agency Regional Screening Level (RSL) December 2009

[5] Total PAHs and PCBs calculated using sum of detects.

[6] VOC non-detects were removed from this table

[7] Screening level is based on 100% hexavalent chromium

[8] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg/kg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is presented

Table 1

Risk Screening Results for Chemicals of Intere

Northwest Pipe Company

Station ID		SS315	SS315	SS316	SS317	SS318	SS319	SS320	SS321												
Sample ID		SS315-0	SS315-1	SS316-0	SS317-0	SS318-0	SS319-0	SS320-0	SS321-0	SS-401-101909-0	SS-402-101909-0	SS-403-101909-0	SS-404-101909-0	SS-405-101909-0	SS-406-101909-0	SS-407-101909-0	SS-408-101909-0	SS-409-101909-0	SS-410-101909-0	SS-411-101909-0	SS-411-101909-1
Date Sampled		09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07	09/25/07												
Depth:																					
Sample QA Type:		N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD
Analyte	**CAS No.**																				
Inorganics (mg/kg):																					
Aluminum	7429-90-5									**7,040**	**4,720**	**5,450**	**3,730**	**15,800**	**3,160**	**24,200**	**13,000**	**10,600**	**27,000**	**5,430**	**6,310**
Antimony	7440-36-0									0.611 U	0.569 U	0.592 U	0.627 U	**3.96**	0.606 U	**2.46**	**2.48**	0.654 U	0.626 U	**1.49 J**	**1.03 J**
Arsenic	7440-38-2									**2.65 J**	**2.28 J**	**2.92 J**	**1.88 J**	**3.57 J**	**7.80 J**	**4.59 J**	**1.57 J**	**7.21 J**	**31.5**	**10.6 J**	**10.1 J**
Cadmium	7440-43-9									**1.00 J**	**1.08 J**	**1.11 J**	**0.916 J**	**5.73**	**7.31**	**6.26**	**4.53**	**8.97**	**1.73 J**	**9.01**	**8.05**
Chromium	7440-47-3									**35.6**	**33.6**	**30.0**	**50.5**	**2,360**	**970**	**3,620**	**2,020**	**121**	**45.6**	**261**	**268**
Copper	7440-50-8									**46.9**	**40.5**	**27.6**	**31.5**	**114**	**240**	**137**	**75.4**	**152**	**34.7**	**255 J**	**139 J**
Lead	7439-92-1									**6.48 J**	**16.7**	**9.99 J**	**53.1**	**22.1**	**14.1**	**20.9**	**10.6**	**160**	**35.3**	**195**	**167**
Mercury	7439-97-6									**0.0140 J**	**0.0104 J**	**0.00633 J**	0.00605 U	**0.00647 J**	0.00614 U	**0.0105 J**	0.00488 U	**0.0897**	**0.0218 J**	**0.0944 J**	**0.203 J**
Nickel	7440-02-0									**22.0**	**17.1**	**14.5**	**16.7**	**35.4**	**519**	**36.7**	**12.4**	**52.5**	**29.2**	**61.6**	**54.6**
Selenium	7782-49-2									0.491 U	0.457 U	0.475 U	0.504 U	0.491 U	0.487 U	**1.94 J**	**0.696 J**	0.525 U	**12.1 J**	0.517 U	0.493 U
Silver	7440-22-4									**0.132 J**	**0.182 J**	**0.185 J**	**0.117 J**	**2.54 J**	**0.665 J**	**3.55**	**2.05 J**	**0.922 J**	**4.01**	**1.50 J**	**1.35 J**
Zinc	7440-66-6									**91.9**	**152**	**98.8**	**87.0**	**126**	**144**	**97.8**	**74.6**	**753**	**163**	**737**	**756**
Organochlorine Pesticides (mg/kg):[4]																					
alpha-BHC	319-84-6									0.000726 U	0.00176 U	0.00178 U	0.00194 U	0.00188 U	0.00184 U	0.000751 U	0.000708 U	**0.00678 J**	0.0019 U	0.00385 U	0.00376 U
Polynuclear Aromatic Hydrocabons (mg																					
Acenaphthene	83-32-9	**0.00298 J**	**0.00367 J**	**0.00463**		**0.0247 J**		**0.024 J**	**3.72**	**0.00545 J**		**0.00567 J**	**0.0589**	**0.0339 J**	**0.0498 J**	**0.0156**	0.00354 U			**2.02**	**2.27**
Acenaphthylene	208-96-8	**0.00768 J**	**0.0129 J**	**0.0032**		**0.0909**		**0.24**	0.18 U	0.00362 U		**0.00366 J**	**0.0116 J**	**0.276**	**0.0846 J**	**0.0163**	**0.00545 J**			**0.197**	**0.155**
Anthracene	120-12-7	**0.0159 J**	**0.0227**	**0.0178**		**0.2**		**0.603**	**19.2**	**0.0104 J**		**0.025**	**0.272**	**0.413**	**0.156 J**	**0.0411**	**0.0112 J**			**10.1**	**8.41**
Benzo (a) anthracene	56-55-3	**0.0746**	**0.0841**	**0.0843**		**1.57**		**1.47**	**51.6**	**0.0736**		**0.376**	**1.78**	**1.67 J**	**0.545**	**0.252**	**0.0411**			**54.2**	**37.2**
Benzo (a) pyrene	50-32-8	**0.0976**	**0.0999**	**0.0888**		**0.734**		**0.917**	**38.2**	**0.0786**		**0.43**	**1.49**	**1.55**	**0.274 J**	**0.257**	**0.0515**			**35.3**	**24.2**
Benzo (b) fluoranthene	205-99-2	**0.246**	**0.275**	**0.137**		**2.18**		**2.78**	**58.2**	**0.091**		**0.506**	**1.67**	**2.18**	**2.16**	**0.375**	**0.0965**			**38.6**	**27.6**
Benzo (g,h,i) perylene	191-24-2	**0.151**	**0.116**	**0.0628**		**0.922**		**0.584**	**17.5**	**0.0726**		**0.371**	**1.05**	**1.18**	**1.8**	**0.218**	**0.0628**			**19.1**	**13.2**
Benzo (k) fluoranthene	207-08-9	**0.121**	**0.0663**	**0.0485**		**0.845**		**0.941**	**30.1**	**0.0718**		**0.479**	**1.31**	**1.71**	**1.79**	**0.223**	**0.0687**			**36.7**	**24.3**
Chrysene	218-01-9	**0.129**	**0.113**	**0.0828**		**2.82**		**2.15**	**57.3**	**0.0941**		**0.51**	**1.98**	**2.09 J**	**1.64**	**0.339**	**0.0685**			**56.2**	**38.2**
Dibenzo (a,h) anthracene	53-70-3	**0.026 J**	**0.0268**	**0.0134**		**0.203**		**0.136**	**5.4**	**0.0181**		**0.105**	**0.367**	**0.451**	**0.29 J**	**0.063**	**0.0163**			**6.35**	**4.34**
Fluoranthene	206-44-0	**0.135**	**0.142**	**0.167**		**1.88**		**2.37**	**166**	**0.168**		**0.421**	**3.45**	**1.68**	**1.78**	**0.457**	**0.0701**			**115**	**83.1**
Fluorene	86-73-7	0.00342 U	**0.00404 J**	**0.00443**		**0.0122 J**		**0.0472 J**	**3.07**	**0.00623 J**		**0.0046 J**	**0.0631**	**0.0387 J**	**0.0582 J**	**0.00944 J**	0.00354 U			**2.13**	**2.01**
Indeno (1,2,3-cd) pyrene	193-39-5	**0.0958**	**0.0864**	**0.0492**		**0.598**		**0.481**	**14**	**0.0614**		**0.326**	**0.959**	**1.16**	**1.14**	**0.199**	**0.0518**			**19.2**	**13.1**
Naphthalene	91-20-3	**0.00539 J**	**0.00549 J**	**0.00195**		**0.0104 J**		**0.0228 J**	**0.599 J**	**0.0123 J**		**0.00446 J**	**0.0171**	**0.0178 J**	**0.139**	**0.0075 J**	0.00354 U			**0.631 J**	**0.135 J**
Phenanthrene	85-01-8	**0.0375**	**0.0433**	**0.0683**		**0.232**		**0.361**	**61**	**0.0773**		**0.0771**	**1.38**	**0.462**	**0.443**	**0.143**	**0.0184**			**46.8**	**35.4**
Pyrene	129-00-0	**0.143**	**0.146**	**0.153**		**2.12**		**2.48**	**175**	**0.15**		**0.439**	**3.07**	**1.7**	**1.9**	**0.283**	**0.0633**			**127**	**86.5**
Total PAHs[5]		**1.3**	**1.2**	**1.0**		**14.4**		**15.6**	**700.9**	**0.99**		**4.1**	**18.9**	**16.6**	**14.2**	**2.9**	**0.63**			**569.5**	**400.1**
Polychlorinated Biphenyls (mg/kg)[6]																					
Aroclor-1254	11097-69-1									**0.0658**	**0.368**	**0.54**	**0.302**	**0.399**	**0.46**	**0.12**	**0.025**	**8.74**	**0.181**	**1.14**	**0.948**
Aroclor-1260	11096-82-5									0.00367 U	0.0178 U	0.036 U	0.0196 U	0.0191 U	0.0372 U	0.0076 U	0.00179 U	0.408 U	0.00768 U	0.0975 U	0.0761 U
Total PCBs[5]										**0.07**	**0.37**	**0.54**	**0.30**	**0.40**	**0.46**	**0.12**	**0.03**	**8.74**	**0.18**	**1.1**	**0.9**
Phthalates (mg/kg):																					
Bis(2-ethylhexyl)phthalate	117-81-7									**0.0668**	**0.389 J**	**0.191**	**0.325**	**0.139**	**0.335**	**0.467**	**0.0603**	**0.667**	**0.178**	**1.9 J**	**2.97**
Butyl benzyl phthalate	85-68-7									**0.382**	**0.0846 J**	**0.0283 J**	**0.075**	**0.0373 J**	0.148 U	**0.031**	**0.0145 J**	0.163 U	**0.0492**	**0.637 J**	**0.501 J**
Di-n-butyl phthalate	84-74-2									0.0147 U	0.0707 U	0.0144 U	0.0314 U	0.0306 U	0.148 U	0.0151 U	0.0144 U	0.163 U	0.0153 U	0.157 U	**0.38 J**
Total Petroleum Hydrocarbons (mg/kg)																					
Diesel		**35 J**	**36.3 J**	**6.8 J**	**342 J**	**36.5 J**	**288 J**	**183 J**	**594**												
VOCs (mg/kg)[6]																					
Methylene Chloride	75-09-2																				
Tetrachloroethene	127-18-4																				
Trichloroethene	79-01-6																				

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation for Occupational Scenario September 15, 2009

2 DEQ Risk Based Concentrations Soil Volatilization to Outdoor Air for Occupational Scenario September 15, 2009

[3] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[4] Environmental Protection Agency Regional Screening Level (RSL) December 2009

[5] Total PAHs and PCBs calculated using sum of detects.

[6] VOC non-detects were removed from this table

[7] Screening level is based on 100% hexavalent chromium

[8] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg/kg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is presented

Table 1
Risk Screening Results for Chemicals of Intere
Northwest Pipe Company

Station ID		GP-05	GP-05	TP-1	TP-1	TP-2	TP-2	TP-3	TP-3
Sample ID		GP05-2_5-083003-0	GP53091001	TP-101-1	TP-101-3	TP-102-1	TP-102-3	TP-103-1	TP-103-3
Date Sampled		08/30/02	09/10/01	1/11/2008	1/11/2008	1/11/2008	1/11/2008	1/11/2008	1/11/2008
Depth:		2.5	3	1	3	1	3	1	3
Sample QA Type:		N	N	N	N	N	N	N	N
Analyte	**CAS No.**								
Inorganics (mg/kg):									
Aluminum	7429-90-5								
Antimony	7440-36-0								
Arsenic	7440-38-2								
Cadmium	7440-43-9								
Chromium	7440-47-3								
Copper	7440-50-8								
Lead	7439-92-1								
Mercury	7439-97-6								
Nickel	7440-02-0								
Selenium	7782-49-2								
Silver	7440-22-4								
Zinc	7440-66-6			**185**	**50.8**	**33.1**	**46.6**	**39.4**	**40.5**
Organochlorine Pesticides (mg/kg):[4]									
alpha-BHC	319-84-6								
Polynuclear Aromatic Hydrocabons (mg									
Acenaphthene	83-32-9			**0.007 J**	**0.003 J**	**0.005**	0.003 U	**0.001 J**	0.003 U
Acenaphthylene	208-96-8			**0.010 J**	**0.008 J**	**0.004**	**0.001 J**	**0.013**	**0.001 J**
Anthracene	120-12-7			**0.103**	**0.012**	**0.017**	**0.001 J**	**0.011**	**0.001 J**
Benzo (a) anthracene	56-55-3			**0.642**	**0.022**	**0.133**	**0.003 J**	**0.016**	**0.001 J**
Benzo (a) pyrene	50-32-8			**0.670**	**0.016**	**0.105**	**0.004**	**0.030**	**0.002 J**
Benzo (b) fluoranthene	205-99-2			**0.852**	**0.024**	**0.159**	**0.005**	**0.031**	**0.003**
Benzo (g,h,i) perylene	191-24-2			**0.369**	**0.010**	**0.064**	**0.004**	**0.043**	**0.002 J**
Benzo (k) fluoranthene	207-08-9			**0.329**	**0.009**	**0.059**	**0.001 J**	**0.013**	**0.001 J**
Chrysene	218-01-9			**0.730**	**0.024**	**0.136**	**0.003 J**	**0.019**	**0.002 J**
Dibenzo (a,h) anthracene	53-70-3			**0.100**	**0.002 J**	**0.018**	0.003 U	**0.005**	0.003 U
Fluoranthene	206-44-0			**0.554**	**0.042**	**0.180**	**0.003**	**0.015**	**0.002 J**
Fluorene	86-73-7			**0.006 J**	**0.003**	**0.003**	0.003 U	**0.001 J**	0.003 U
Indeno (1,2,3-cd) pyrene	193-39-5			**0.306**	**0.008**	**0.052**	**0.002 J**	**0.022**	**0.001 J**
Naphthalene	91-20-3			**0.003 J**	**0.001 J**	**0.002 J**	**0.000 J**	**0.002 J**	**0.000 J**
Phenanthrene	85-01-8			**0.108**	**0.022**	**0.041**	**0.001 J**	**0.005**	**0.001 J**
Pyrene	129-00-0			**0.672**	**0.040**	**0.187**	**0.004**	**0.023**	**0.008**
Total PAHs[5]				**5.4603**	**0.2453**	**1.1636**	**0.03114**	**0.24842**	**0.02526**
Polychlorinated Biphenyls (mg/kg)[6]									
Aroclor-1254	11097-69-1			**2.94**	0.0236 U	0.0236 U	0.0231 U	0.0238 U	0.0233 U
Aroclor-1260	11096-82-5			0.233 U	0.0236 U	**0.119**	0.0231 U	0.0238 U	0.0233 U
Total PCBs[5]				**2.94**		**0.119**			
Phthalates (mg/kg):									
Bis(2-ethylhexyl)phthalate	117-81-7								
Butyl benzyl phthalate	85-68-7								
Di-n-butyl phthalate	84-74-2								
Total Petroleum Hydrocarbons (mg/kg)									
Diesel									
VOCs (mg/kg)[6]									
Methylene Chloride	75-09-2	0.0011 U	**0.0012**						
Tetrachloroethene	127-18-4	**0.0148**	0.001 U						
Trichloroethene	79-01-6	**0.0014**	0.001 U						

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate
[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation for Occupational Scenario September 15, 2009
2 DEQ Risk Based Concentrations Soil Volatilization to Outdoor Air for Occupational Scenario September 15, 2009
[3] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009
[4] Environmental Protection Agency Regional Screening Level (RSL) December 2009
[5] Total PAHs and PCBs calculated using sum of detects.
[6] VOC non-detects were removed from this table
[7] Screening level is based on 100% hexavalent chromium
[8] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram
Bold result = detection
Shaded cell = screening criteria exceeded.
-- = no screening level available
J = Estimated value below reporting limit.
U = Not detected at specified reporting limit.
> max = the constituent RBC for this pathway is greater an 100,000 mg/kg
c = RBCs calculated using equations for carcinogens
nc = RBCs calculated using equations for non-carcinogens
c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is pr

Table 2

Risk Screening Results for Chemicals of Interest Detected in Subsurface Soil

Northwest Pipe Company

Station ID:							GP-01	GP-02	GP-03	GP-05	GP-05	GP-201	GP-202	GP-203	GP-203	GP-204
Sample ID:							GP16090701	GP218091001	GP03-9-082902-0	GP56091001	GP05-13_5-083002-0	GP201-9-0	GP202-8-0	GP203-8-0	GP203-8-1	GP204-9-0
Date Collected:							09/07/01	09/10/01	08/29/02	09/10/01	08/30/02	9/26/2007	9/26/2007	9/26/2007	9/26/2007	9/26/2007
Depth:							6	18	9	6	13.5	0 - 9	0 - 8	0 - 8	0 - 8	0 - 9
Sample QA Type:							N	N	N	N	N	N	N	N	FD	N
Chem Group/Chemical	**CAS_NO**	**Basis of Screening Level**	**DEQ RBC_{SO} [1 5]**		**DEQ RBC_{Si} [2 5]**	**Maximum**										
			Construction Worker	**Excavation Worker**	**Occupational**	**Detected Value**										
Inorganics (mg/kg):																
Zinc	7440-66-6	nc	--	--	--	44								**39.3**	**39.7**	**36.7**
Polynuclear Aromatic Hydrocabons (mg/kg):																
Acenaphthene	83-32-9	nc	1,900	>max	--	0.201	0.005 U	0.006 U						0.000166 U	0.000172 U	0.000158 U
Acenaphthylene	208-96-8		--	--	--	0.078	0.005 U	0.006 U						**0.000385 J**	0.000214 U	**0.0025**
Anthracene	120-12-7	nc	9,300	>max	--	0.067	0.005 U	0.006 U						**0.00107 J**	0.000422 U	**0.0011 J**
Benzo (a) anthracene	56-55-3	c	21	590	--	0.026	0.005 U	0.006 U						**0.000736 J**	**0.000757 J**	**0.0031**
Benzo (a) pyrene	50-32-8	c	2.1	59	--	0.006	0.005 U	0.006 U						**0.000841 J**	**0.000891 J**	
Benzo (b) fluoranthene	205-99-2	c	21	590	--	0.120	0.005 U	0.006 U						**0.00121 J**	**0.00131 J**	**0.00754**
Benzo (g,h,i) perylene	191-24-2		--	--	--	0.049	0.005 U	0.006 U						**0.00117 J**	0.000679 UJ	**0.00975**
Benzo (k) fluoranthene	207-08-9	c	210	5,900	--	0.107	0.005 U	0.006 U						**0.000535 J**	**0.000712 J**	**0.00315**
Chrysene	218-01-9	c	2,100	59,000	--	0.031	0.005 U	0.006 U						**0.000701 J**	**0.00107 J**	**0.00293**
Dibenzo (a,h) anthracene	53-70-3	c	2.1	59	--	0.006	0.005 U	0.006 U						**0.000261 J**	0.000155 U	**0.000894 J**
Fluoranthene	206-44-0	nc	890	>max	--	0.066	0.005 U	0.006 U						**0.000977 J**	**0.000503 J**	**0.00436**
Fluorene	86-73-7	nc	1,200	>max	--	0.440	0.005 U	0.006 U						0.000194 U	0.000202 U	0.000185 U
Indeno (1,2,3-cd) pyrene	193-39-5	c	21	590	--	0.056	0.005 U	0.006 U						**0.000883 J**	0.000475 UJ	**0.0058**
Naphthalene	91-20-3	c, nc	74	2,100	99	0.421	0.005 U	0.006 U						0.000209 U	**0.000349 J**	**0.000359 J**
Phenanthrene	85-01-8		--	--	--	0.279	0.005 U	0.006 U						**0.000388 J**	**0.000262 J**	**0.00039 J**
Pyrene	129-00-0	nc	670	>max	--	0.070	0.005 U	0.006 U						**0.000946 J**	**0.000522 J**	**0.00722**
Total PAH[3]			--	--	--	0										
Polychlorinated Biphenyls (mg/kg):																
Aroclor-1016	12674-11-2		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Aroclor-1221	11104-28-2		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Aroclor-1232	11141-16-5		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Aroclor-1242	53469-21-9		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Aroclor-1248	12672-29-6		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Aroclor-1254	11097-69-1		--	--	--	0.19								0.028 U	0.0298 U	0.0258 U
Aroclor-1260	11096-82-5		--	--	--	0.030								0.028 U	0.0298 U	0.0258 U
Total PCBs[3]		c, nc	4.40	120	--	0.00										
Total Petroleum Hydrocarbons (mg/kg):																
Diesel	DIESEL_Dx		23,000	>max	>max	3,470						**2.6 J**	**1.6 J**	**1.7 J**	**2.1 J**	**1.5 J**
Gasoline by Gx	GAS_Gx		13,000	>max	>max	0.52						**0.05 J**	**0.042 J**	**0.093 J**	0.45 UJ	**0.044 J**
VOCs (mg/kg) [4]																
Chlorobenzene	108-90-7	nc	430	>max	--	0.010	0.0011 U	0.0012 U	0.0011 U	0.0011 U	0.0012 U			0.0096 U	0.0068 U	0.0061 U
Cis-1,2-Dichloroethene	156-59-2	nc	310	8,600	>max	0.015	0.0011 U	**0.0152**	0.0011 U	0.0011 U	0.0012 U			**0.0012 J**	**0.0042 J**	0.0061 U
Methylene Chloride	75-09-2		--	--	--	0.010	0.0011 U	0.0012 U	0.0011 U	**0.0013**	0.0012 U			0.0096 U	0.0068 U	0.0061 U
Tetrachloroethene	127-18-4	c	40	1,100	1.6	0.726	0.0011 U	**0.726 D**	**0.0376**	0.0011 U	**0.0024**			**0.0537**	**0.0655**	0.0061 U
Trichloroethene	79-01-6	c	43	1,200	0.13	0.017	0.0011 U	**0.0171**	0.0011 U	0.0011 U	0.0012 U			**0.00054 J**	**0.00087 J**	0.0061 U

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation September 15, 2009

[2] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[3] Total PAHs and PCBs calculated using sum of detects.

[4] VOC non-detects were removed from this table

[5] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg/kg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lower RBC is presented

Table 2

Risk Screening Results for Chemicals of Interest Detected in Subsu

Northwest Pipe Company

Station ID:		GP-205	GP-206	GP-207	GP-208	GP-209	GP-210	GP-211	GP-211	GP-212	GP-213	GP-214
Sample ID:		GP205-9-0	GP206-9-0	GP207-9-0	GP208-9-0	GP209-9-0	GP210-9-0	GP211-9-0	GP211-9-1	GP212-9-0	GP213-10-0	GP214-10-0
Date Collected:		9/26/2007	9/26/2007	9/26/2007	9/27/2007	9/27/2007	9/27/2007	9/27/2007	9/27/2007	9/27/2007	9/27/2007	9/27/2007
Depth:		0 - 9	0 - 9	0 - 9	0 - 9	0 - 9	0 - 9	0 - 9	0 - 9	0 - 9	0 - 10	0 - 10
Sample QA Type:		N	N	N	N	N	N	N	FD	N	N	N
Chem Group/Chemical	**CAS_NO**											
Inorganics (mg/kg):												
Zinc	7440-66-6		**40.3**	**40.7**			**37**			**43.9**		**38**
Polynuclear Aromatic Hydrocabons (mg/kg):												
Acenaphthene	83-32-9		0.000161 U	0.000171 U		0.000178 U	0.000153 U	0.000153 U	0.000155 U	**0.201**		0.000169 U
Acenaphthylene	208-96-8		0.000201 U	0.000213 U		0.000221 U	**0.000338 J**	0.00019 U	0.000192 U	**0.0783**		0.00021 U
Anthracene	120-12-7		0.000394 U	0.000418 U		0.000434 U	**0.00038 J**	0.000374 U	0.000378 U	**0.0668**		0.000411 U
Benzo (a) anthracene	56-55-3		**0.000226 J**	**0.00122 J**		**0.000618 J**	**0.00351**	0.000123 U	0.000125 U	**0.0263 J**		0.000135 U
Benzo (a) pyrene	50-32-8		0.000589 U	**0.00151 J**		0.000649 U	**0.0036**	0.000559 U	0.000566 U			0.000614 U
Benzo (b) fluoranthene	205-99-2		0.000276 UJ	**0.00713**		0.000608 UJ	**0.0041**	0.000123 U	0.000125 U	**0.12**		0.000135 U
Benzo (g,h,i) perylene	191-24-2		0.00039 UJ	**0.00217**		0.000452 UJ	**0.00286**	0.000156 U	0.000158 U	**0.0489**		**0.00202**
Benzo (k) fluoranthene	207-08-9		0.000247 U	**0.00314**		**0.000294 J**	**0.00252**	0.000234 U	0.000238 U	**0.107**		0.000258 U
Chrysene	218-01-9		0.000373 U	**0.00268**		**0.000713 J**	**0.00323**	0.000354 U	0.000358 U	**0.0314 J**		0.000389 U
Dibenzo (a,h) anthracene	53-70-3		**0.000265 J**	**0.000445 J**		0.00016 U	**0.000422 J**	0.000138 U	0.000139 U	0.0031 U		0.000152 U
Fluoranthene	206-44-0		**0.000272 J**	**0.00634**		**0.00147 J**	**0.00602**	0.00019 U	0.000192 U	**0.0659**		**0.000301 J**
Fluorene	86-73-7		0.000189 U	0.0002 U		0.000209 U	0.000178 U	0.00018 U	0.000182 U	**0.44**		0.000198 U
Indeno (1,2,3-cd) pyrene	193-39-5		0.000327 UJ	**0.00136 J**		0.000259 UJ	**0.00176 J**	0.000146 U	0.000147 U	**0.0555**		0.00016 U
Naphthalene	91-20-3		**0.000205 J**	**0.00026 J**		**0.000399 J**	**0.000268 J**	0.000192 U	0.000196 U	**0.421**		**0.000648 J**
Phenanthrene	85-01-8		0.000174 U	**0.000525 J**		**0.000491 J**	**0.00124 J**	0.000166 U	0.000168 U	**0.279**		**0.000428 J**
Pyrene	129-00-0		**0.000233 J**	**0.00514**		**0.00136 J**	**0.00628**	0.000212 U	0.000215 U	**0.0697**		**0.00031 J**
Total PAH[3]												
Polychlorinated Biphenyls (mg/kg):												
Aroclor-1016	12674-11-2		0.0279 U				0.026 U			0.028 U		
Aroclor-1221	11104-28-2		0.0279 U				0.026 U			0.028 U		
Aroclor-1232	11141-16-5		0.0279 U				0.026 U			0.028 U		
Aroclor-1242	53469-21-9		0.0279 U				0.026 U			0.028 U		
Aroclor-1248	12672-29-6		0.0279 U				0.026 U			0.028 U		
Aroclor-1254	11097-69-1		0.0279 U				0.026 U			**0.186**		
Aroclor-1260	11096-82-5		0.0279 U				0.026 U			0.028 U		
Total PCBs[3]												
Total Petroleum Hydrocarbons (mg/kg):												
Diesel	DIESEL_Dx	**2 J**	**1.6 J**	**12.7 J**	**6.7 J**	**2 J**	**1.7 J**	**1.7 J**	**1.5 J**	**3470**	**2 J**	**2.1 J**
Gasoline by Gx	GAS_Gx	**0.081 J**	**0.094 J**	0.5 UJ	0.24 UJ	0.31 UJ	0.28 UJ	0.16 UJ	0.52 UJ	0.35 UJ	0.16 UJ	0.12 UJ
VOCs (mg/kg) [4]												
Chlorobenzene	108-90-7		0.006 U	**0.00031 J**		0.006 U	0.0068 U			0.0062 U		
Cis-1,2-Dichloroethene	156-59-2		0.006 U	0.0061 U		0.006 U	0.0068 U			0.0062 U		
Methylene Chloride	75-09-2		0.006 U	0.0061 U		0.006 U	0.0068 U			0.0062 U		
Tetrachloroethene	127-18-4		0.006 U	0.0061 U		0.006 U	0.0068 U			**0.001 J**		
Trichloroethene	79-01-6		0.006 U	0.0061 U		0.006 U	0.0068 U			0.0062 U		

Notes:

*Samples type: N = Normal sample, FD = Field Duplicate

[1] DEQ Risk Based Concentrations Soil Ingestion, Dermal Contact and Inhalation September 15, 2009

[2] DEQ Risk Based Concentrations Soil Vapor Intrusion into Buildings for Occupational Scenario September 15, 2009

[3] Total PAHs and PCBs calculated using sum of detects.

[4] VOC non-detects were removed from this table

[b] Screening level were adjusted to equate to 10^{-6} cancer risk and a hazard quotient of 0.1 non-cancer risk for individual COIs.

mg/Kg = milligrams per kilogram

Bold result = detection

Shaded cell = screening criteria exceeded.

-- = no screening level available

J = Estimated value below reporting limit.

U = Not detected at specified reporting limit.

> max = the constituent RBC for this pathway is greater an 100,000 mg

c = RBCs calculated using equations for carcinogens

nc = RBCs calculated using equations for non-carcinogens

c, nc = RBCs calculated using cancer and non-cancer equations with lo

Table 3

Summary of Hot Spot Screening Values

Northwest Pipe Company

Analyte	Units	Hor Spot Screening Values	Joint Source Control SLVs[1]
PAH			
Acenaphthene	mg/Kg	3	0.300
Acenaphthylene	mg/Kg	2	0.200
Anthracene	mg/Kg	8.45	0.845
Benzo (a) anthracene	mg/Kg	10.5	1.050
Benzo (a) pyrene	mg/Kg	14.5	1.450
Benzo (b) fluoranthene	mg/Kg		--
Benzo (g,h,i) perylene	mg/Kg	3	0.300
Benzo (k) fluoranthene	mg/Kg	130	13.000
Chrysene	mg/Kg	12.9	1.290
Dibenzo (a,h) anthracene	mg/Kg	13	1.300
Fluoranthene	mg/Kg	22.3	2.230
Fluorene	mg/Kg	5.36	0.536
Indeno (1,2,3-cd) pyrene	mg/Kg	1	0.100
Naphthalene	mg/Kg	5.61	0.561
Phenanthrene	mg/Kg	11.7	1.170
Pyrene	mg/Kg	15.2	1.520
Total PAHs[3]	mg/Kg	228	22.800
Metals Total		0	
Zinc	mg/Kg	4590	459.000
PCBs		0	
Aroclor-1016	mg/Kg	5.3	0.530
Aroclor-1221	mg/Kg		--
Aroclor-1232	mg/Kg		--
Aroclor-1242	mg/Kg		--
Aroclor-1248	mg/Kg	15	1.500
Aroclor-1254	mg/Kg	3	0.300
Aroclor-1260	mg/Kg	2	0.200
Aroclor-1262	mg/Kg		--
Aroclor-1268	mg/Kg		--
Total PCBs	mg/Kg	0.0039	0.00039
TPH		0	
Diesel	mg/Kg	390020	3900[2]
VOCs		0	

Notes:

*Samples type: N1 = Normal sample, FD1 = Field Duplicate

B = Blank contamination

D = Analyzed at a secondary dilution factor

U = The analyte was analyzed for, but not detected.

Bolded = detect

Shaded = detected result exceeded selected criteria

-- = Not Established

[1] Screening level values taken from Table 3-1 of the Portland Harbor Joint Source Control Strategy, Revised July 2007

[2] Screening level values taken from DEQ Risk-Based Decision Making for Petroleum Contaminated Sites, Soil Ingestion, Dermal Contact and Inhalation, Occupational Scenario. Revised July 2007

[3] Total PAH PEC based on MacDonald et al. 2000

These preliminary screening levels are intended to provide conservative values that are useful for placing reported constituent concentrations into context. They do not represent cleanup levels levels and are not based on promulgated regulations.

Table 4
Detailed Evaluation of Remedial Alternatives
Northwest Pipe

	Remedial Alternatives			
Remedy Evaluation Criteria (OAR 340-122-090)	**Alternative 1 - No Action**	**Alternative 2 - Excavation and Asphalt Capping**	**Alternative 3 - Asphalt Capping With Use Restriction**	**Alternative 4 - Hot Spot Excavation and Asphalt Capping With Use Restriction**
Protectiveness	Not Protective	Protective	Protective	Protective
Effectiveness	Low No reduction in risk is achieved. Time to reach cleanup goal is unknown.	High Risk levels would be reduced to acceptable levels under this option. More effective than Alternatives 3 and 4 due to more extensive removal No exposure pathway will remain following action implementation	High/Moderate Human health and ecological risk levels may be reduced but not ensured. Less effective than Alternative 2 and Alternative 4 due to no removal of material. No exposure pathway will remain following action implementation.	High/Moderate Human health and ecological risk levels may be reduced but not ensured. Less effective than Alternative 2 due to less material being removed, but more effective than Alternative 3 due to limited removal of material. No exposure pathway will remain following action implementation
Long Term Reliability	Low No reduction of risk is achieved. No long-term management is required for this alternative.	High	Moderate Risk of direct contact is reduced by cap onsite. Long-term monitoring would consist of inspecting the cap for signs of deterioration.	Moderate Risk of direct contact is reduced by cap onsite. Long-term monitoring would consist of inspecting the cap for signs of deterioration.
Ease of Implementability	High There would be no technical difficulties involved in implementing the no-action alternative. No federal, state, or local requirements are needed to implement the no-action alternative.	Low Implementation of this alternative would require conventional construction techniques, and there should be no difficulty obtaining needed material unless the schedule is accelerated. Necessary State and local requirements would be adhered to during disposal of material. A Site Development Permit would be required from the City of Portland to proceed with this Alternative. The Site Development Plan would include; an Erosion and Sediment Control Plan, a Utility Plan, a Grading Plan, and a Stormwater report. A 1200-C NPDES stormwater permit would also be required from DEQ prior to construction.	Moderate/Low Implementation of this alternative would require conventional construction techniques, and there should be no difficulty obtaining needed material unless the schedule is accelerated. A Site Development Permit would be required from the City of Portland to proceed with this Alternative. The Site Development Plan would include; an Erosion and Sediment Control Plan, a Utility Plan, a Grading Plan, and a Stormwater report. A 1200-C NPDES stormwater permit would also be required from DEQ prior to construction.	Moderate Implementation of this alternative would require conventional construction techniques, and there should be no difficulty obtaining needed material unless the schedule is accelerated. necessary State and local requirements would be adhered to during disposal of material. A Site Development Permit would be required from the City of Portland to proceed with this Alternative. The Site Development Plan would include; an Erosion and Sediment Control Plan, a Utility Plan, a Grading Plan, and a Stormwater report. A 1200-C NPDES stormwater permit would also be required from DEQ prior to construction.
Implementation Risk	Low There would be no potential impacts on the community, workers, or the environment, when applying the no-action alternative. Though the time required for remedial action completion is zero, the time required for reaching cleanup goals is indefinite.	High Slight risk of worker exposure if dust control measures are not used. Slight risk of release to the environment during excavation and transporting of material. Remedial alternative could be completed in less than one year.	Moderate/Low Slight risk of worker exposure if dust control measures are not used. Remedial alternative could be completed in less than one year.	Moderate/Low Slight risk of worker exposure if dust control measures are not used. Slight risk of release to the environment during excavation and transporting of material. Remedial alternative could be completed in less than one year.
Reasonableness of Cost	High Cost estimate = $0 Because this alternative is not considered protective, the benefit to cost ratio for this alternative cannot be evaluated.	Low $4,472,620 High human risk and ecological receptor reduction achieved through reduction of probability of exposure. The costs for this alternative are relatively certain.	High $1,756,638 High human risk and ecological receptor reduction achieved through reduction of probability of exposure. The costs for this alternative are relatively certain.	Moderate $1,937,914 High human risk and ecological receptor reduction achieved through reduction of probability of exposure. The costs for this alternative are relatively certain.
Treatment of Hot Spots	Not Applicable - no treatment	Hot spot areas will be excavated and disposed offsite.	Not Applicable - no treatment	Hot spot areas will be excavated and disposed offsite.

Table 5
Preliminary Budgetary Cost Estimates - Summary
Northwest Pipe company

Northwest Pipe, Surface Soil Risk Screening and Focused Feasibility Study **5/10/2010**

Alternative 2
Soil Excavation and Asphalt Capping

1	**Mobilization**	$	20,000
2	**Site Preparation**	$	3,000
3	**Excavate and disposal of material**	$	1,591,334
4	**Asphalt Capping**	$	719,636
5	**Oversight - Excavation - Capping**	$	293,500
6	**RA/RD**	$	25,000
8	**O&M Costs NPV**	$	29,590
7	**Total Cost for Productivity Reduction**	$	503,566
	Subtotal	**$**	**3,185,627**
	G&A 8%	$	254,850
	Fee 4%	$	137,619
	Contingency 25%	$	894,524
	Total	**$**	**4,472,620**

Alternative 3
Asphalt Capping of All Unpaved Areas

1	**Mobilization**	$	20,000
2	**Site Preparation**	$	3,000
3	**Excavate and disposal of material**	$	16,514
4	**Asphalt Capping**	$	719,636
5	**Oversight - Excavation - Capping**	$	293,500
6	**RA/RD**	$	25,000
8	**O&M Costs NPV**	$	29,590
7	**Total Cost for Productivity Reduction**	$	143,927
	Subtotal	**$**	**1,251,167**
	G&A 8%	$	100,093
	Fee 4%	$	54,050
	Contingency 25%	$	351,328
	Total	**$**	**1,756,638**

Alternative 4
Hot Spot Excavation and Asphalt Capping of All Unpaved Areas

1	**Mobilization**	$	20,000
2	**Site Preparation**	$	3,000
3	**Excavate and disposal of material**	$	128,591
4	**Asphalt Capping**	$	719,636
5	**Oversight - Excavation - Capping**	$	293,500
6	**RA/RD**	$	25,000
8	**O&M Costs NPV**	$	29,590
7	**Total Cost for Productivity Reduction**	$	160,964
	Subtotal	**$**	**1,380,281**
	G&A 8%	$	110,422
	Fee 4%	$	59,628
	Contingency 25%	$	387,583
	Total	**$**	**1,937,914**

Table 6
Preliminary Budgetary Cost Estimate - Alternative 2
Northwest Pipe company

Northwest Pipe, Surface Soil Risk Screening and Focused Feasibility Stud **5/10/2010**
Alternative 2 **Soil Excavation & Asphalt Cap**

Description: Excavation and Asphalt Capping

Task 1	Excavate soil exceeding Screening Levels
Task 2	Transport and Dispose of material
Task 3	Fill excavated area with aggregate
Task 4	Place 4"asphalt cap

Design Criteria

Area	172498	sf
Volume of material to be removed (2ft Depth)	12,778	cy
Total Mass Soil to be removed@1.5 tons/bcy	19,166	tons
Area of material to be capped	19,166	SY
Thickness of Asphalt Cap	4	Inch
Transportation cost	$ 13.03	ton
Disposal	$ 55.00	ton

Capital Cost	Unit Cost	Quantity	Unit of Measure	Total Cost	Subject to Productivity Reduction?
1 Mobilization					
Subcontractor mobilization	$ 20,000.00	1	LS	$ 20,000	**No**
2 Site Preparation					
Erosion Control	$ 3,000.00	1	LS	$ 3,000	**No**
3 Excavate and disposal of material					
Remove material	$ 2.50	12,778	CY	$ 31,944	**Yes**
Transport of material	$ 13.03	19,166	tons	$ 249,683	**No**
Disposal fees	$ 55.00	19,166	tons	$ 1,054,154	**No**
Backfill excavated area with aggregate	$ 20.00	12,778	CY	$ 255,553	**Yes**
4 Asphalt Capping					
Fine Grade Area	$ 0.90	19,166	SY	$ 17,250	**Yes**
6" Average Depth ABII	$ 40.00	3,194	CY	$ 127,776	**Yes**
Tack Coat	$ 1.90	19,166	SY	$ 36,416	**Yes**
4" Asphalt Cap	$ 3.12	172,498	SF	$ 538,194	**Yes**
5 Oversight - Uplands Material excavation					
Project management	$ 150.00	640	HRS	$ 96,000	
Oversight of Subcontractors	$ 150.00	640	HRS	$ 96,000	
Administrative	$ 75.00	640	HRS	$ 48,000	
Vehicle	$ 250.00	16	wk	$ 4,000	
Supplies/Equipment	$ 500.00	16	wk	$ 8,000	
Site Trailer/Office/Equipment	$ 2,500.00	16	wk	$ 40,000	
Equipment	$ 1,500.00	1	LS	$ 1,500	
6 RA/RD	$ 25,000.00	1	LS	$ 25,000	
7 Total Cost for Productivity Reduction				**$ 503,566**	

	Unit Cost	Quantity	Unit of Measure				
		SUBTOTAL - Alternative 2		**$ 3,156,036**		**$**	**3,156,036**
Operation and Maintenance				**Current $**	**NPV %**		**NPV**
8 Monitor cap integrity							
Field Labor	$ 1,000.00	1	LS	$ 1,000			
Subcontractor	$ 1,500.00	1	LS	$ 1,500			
Surveyor Labor	$ 1,000.00	1	LS	$ 1,000			
Reporting	$ 1,600.00	1	LS	$ 1,600			
		Total	Year 1	$ 5,100	0.952	$	4,855
			Year 2	$ 5,100	0.907	$	4,626
			Year 3	$ 5,100	0.864	$	4,406
			Year 4	$ 5,100	0.823	$	4,197
			Year 5	$ 5,100	0.784	$	3,998
			Year 10	$ 5,100	0.614	$	3,131
			Year 15	$ 5,100	0.481	$	2,453
			Year 20	$ 5,100	0.377	$	1,923
		SUBTOTAL - O&M Costs				**$**	**29,590**
		SUBTOTAL - O&M and Capital Costs					**$3,185,627**
				G&A	8%	$	254,850
					Subtotal	**$**	**3,440,477**
				Fee	4%	$	137,619
					Subtotal	**$**	**3,578,096**
				Contingency	25%	$	894,524
				TOTAL - Alternative 2		**$**	**4,472,620**

Assumptions

1 *Density of the material has been based on 1.5 tons/bcy*
2 *Transportation and disposal is based on 5% overage and a 15% fluff factor. Cost of disposal based on quote from Mark Krening/Waste Management, 08/26/09. Assumes waste is non-hazardous and contains no liquid.*
3 *Loose density and fluff factor will need to be qualified before full scale operation by loading a truck and pup and then weighing it full*
4 *Volume estimates for fill area based on removing top 2 feet of soil.*
5 *Disposal and transport costs based on material going to Waste Management - Riverbend Landfill, in McMinnville, Oregon. Located app. 48 miles away.*
6 *Overall duration has been estimated at 16 weeks to occur within the summer months of June to September*
7 *Volume of dump trailer is estimated at 30 cubic yards.*
8 *Costs for decontamination of trucks, if needed, has not been included.*
9 *It is assumed that Contractor will have to work within the tightly constrained Northwest Pipe Co site, and as such, site activities will impact construction productivy. Productivity reduction was assumed to be 50% of the cost for construction activities that could affect construction productivity.*
10 *The estimate includes costs for construction services only and does not include any costs for additional design work.*
11 *This estimate does not include any costs for third party construction oversight*

Table 7
Preliminary Budgetary Cost Estimate - Alternative 3
Northwest Pipe company

Northwest Pipe, Surface Soil Risk Screening and Focused Feasibility Study **5/10/2010**
Alternative 3 Hot Spot Excavation and Asphalt Capping of All Unpaved Areas

Description: Asphalt Capping

Task 1	Excavate soil exceeding Screening Levels
Task 2	Transport and Dispose of material
Task 3	Fill excavated area with aggregate
Task 4	Place 4"asphalt cap

Design Criteria

Area		172498	sf
Area of material to be capped		19,166	SY
Thickness of Asphalt Cap		4	Inch
Transportation cost	$	13.03	ton
Disposal	$	55.00	ton

Capital Cost		Unit Cost	Quantity	Unit of Measure		Total Cost	Subject to Productivity Reduction?
1 Mobilization							
Subcontractor mobilization	$	20,000.00	1	LS	$	20,000	**No**
2 Site Preparation							
Erosion Control	$	3,000.00	1	LS	$	3,000	**No**
3 Excavate and disposal of material							
Remove sloghed material	$	2.50	300	CY	$	750	**No**
Transport of material	$	13.03	450	tons	$	5,864	**No**
Disposal fees	$	22.00	450	tons	$	9,900	**No**
4 Asphalt Capping							
Fine Grade Area	$	0.90	19,166	SY	$	17,250	**Yes**
6" Average Depth ABII	$	40.00	3,194	CY	$	127,776	**Yes**
Tack Coat	$	1.90	19,166	SY	$	36,416	**Yes**
4" Asphalt Cap	$	3.12	172,498	SF	$	538,194	**Yes**
5 Oversight - Uplands Material excavation							
Project management	$	150.00	640	HRS	$	96,000	
Oversight of Subcontractors	$	150.00	640	HRS	$	96,000	
Administrative	$	75.00	640	HRS	$	48,000	
Vehicle	$	250.00	16	wk	$	4,000	
Supplies/Equipment	$	500.00	16	wk	$	8,000	
Site Trailer/Office/Equipment	$	2,500.00	16	wk	$	40,000	
Equipment	$	1,500.00	1	LS	$	1,500	
6 RA/RD	$	25,000.00	1	LS	$	25,000	
7 Total Cost for Productivity Reduction					**$**	**143,927**	

				SUBTOTAL - Alternative 3	**$**	**1,221,577**		**$**	**1,221,577**
Operation and Maintenance						**Current $**	**NPV %**		**NPV**
1 Monitor cap integrity									
Field Labor	$	1,000.00	1	LS	$	1,000			
Subcontractor	$	1,500.00	1	LS	$	1,500			
Surveyor Labor	$	1,000.00	1	LS	$	1,000			
Reporting	$	1,600.00	1	LS	$	1,600			
			Total	Year 1	$	5,100	0.952	$	4,855
				Year 2	$	5,100	0.907	$	4,626
				Year 3	$	5,100	0.864	$	4,406
				Year 4	$	5,100	0.823	$	4,197
				Year 5	$	5,100	0.784	$	3,998
				Year 10	$	5,100	0.614	$	3,131
				Year 15	$	5,100	0.481	$	2,453
				Year 20	$	5,100	0.377	$	1,923
				SUBTOTAL - O&M Costs				**$**	**29,590**
				SUBTOTAL - O&M and Capital Costs					**$1,251,167**
						G&A	8%	$	100,093
							Subtotal	**$**	**1,351,260**
						Fee	4%	$	54,050
							Subtotal	**$**	**1,405,311**
						Contingency	25%	$	351,328
						TOTAL - Alternative 2		**$**	**1,756,638**

Assumptions

1. *Assumes that 2 inches of surface soil will be generated for waste during site preparation.*
2. *It is assumed that Contractor will have to work within the tightly constrained Northwest Pipe Co site, and as such, site activities will impact construction productivy. Productivity reduction was assumed to be 20% of the cost for construction activities that could affect construction productivity.*
3. *The estimate includes costs for construction services only and does not include any costs for additional design work.*
4. *This estimate does not include any costs for third party construction oversight*

Table 8
Preliminary Budgetary Cost Estimate - Alternative 4
Northwest Pipe company
Alternative 4
Northwest Pipe, Surface Soil Risk Screening and Focused Feasibility Study **5/10/2010**
Alternative 4 **Soil Excavation & Asphalt Cap**

Description: Excavation of Hot Spot and Asphalt Capping

Task 1	Excavate soil exceeding Screening Levels
Task 2	Transport and Dispose of material
Task 3	Fill excavated area with aggregate

Design Criteria

Area		172498	sf
Volume of material to be removed		1,033	cy
Total Mass Soil to be removed@1.2 tons/bcy		1,549	tons
Transportation cost	$	13.03	ton
Disposal	$	55.00	ton

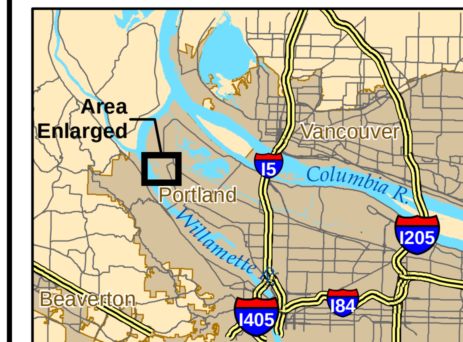
Capital Cost		Unit Cost	Quantity	Unit of Measure		Total Cost	Subject to Productivity Reduction?
1 Mobilization							
Subcontractor mobilization	$	20,000.00	1	LS	$	20,000	**No**
2 Site Preparation							
Erosion Control	$	3,000.00	1	LS	$	3,000	**No**
3 Excavate and disposal of material							
Remove material	$	2.50	1,033	CY	$	2,581	**Yes**
Transport of material	$	13.03	1,549	tons	$	20,176	**No**
Disposal fees	$	55.00	1,549	tons	$	85,183	**No**
Backfill excavated area with aggregate	$	20.00	1,033	CY	$	20,650	**Yes**
4 Asphalt Capping							
Fine Grade Area	$	0.90	19,166	SY	$	17,250	**Yes**
6" Average Depth ABII	$	40.00	3,194	CY	$	127,776	**Yes**
Tack Coat	$	1.90	19,166	SY	$	36,416	**Yes**
4" Asphalt Cap	$	3.12	172,498	SF	$	538,194	**Yes**
5 Oversight - Uplands Material excavation							
Project management	$	150.00	640	HRS	$	96,000	
Oversight of Subcontractors	$	150.00	640	HRS	$	96,000	
Administrative	$	75.00	640	HRS	$	48,000	
Vehicle	$	250.00	16	wk	$	4,000	
Supplies/Equipment	$	500.00	16	wk	$	8,000	
Site Trailer/Office/Equipment	$	2,500.00	16	wk	$	40,000	
Equipment	$	1,500.00	1	LS	$	1,500	
6 RA/RD	$	25,000.00	1	LS	$	25,000	
7 Total Cost for Productivity Reduction					**$**	**160,964**	

			SUBTOTAL - Alternative 4		**$**	**1,350,690**		**$**	**1,350,690**
Operation and Maintenance						**Current $**	**NPV %**		**NPV**
1 Monitor cap integrity									
Field Labor	$	1,000.00	1	LS	$	1,000			
Subcontractor	$	1,500.00	1	LS	$	1,500			
Surveyor Labor	$	1,000.00	1	LS	$	1,000			
Reporting	$	1,600.00	1	LS	$	1,600			
			Total	Year 1	$	5,100	0.952	$	4,855
				Year 2	$	5,100	0.907	$	4,626
				Year 3	$	5,100	0.864	$	4,406
				Year 4	$	5,100	0.823	$	4,197
				Year 5	$	5,100	0.784	$	3,998
				Year 10	$	5,100	0.614	$	3,131
				Year 15	$	5,100	0.481	$	2,453
				Year 20	$	5,100	0.377	$	1,923
			SUBTOTAL - O&M Costs					**$**	**29,590**
			SUBTOTAL - O&M and Capital Costs						**$1,380,281**
						G&A	8%	$	110,422
							Subtotal	**$**	**1,490,703**
						Fee	4%	$	59,628
							Subtotal	**$**	**1,550,331**
						Contingency	25%	$	387,583
						TOTAL - Alternative 4		**$**	**1,937,914**

Assumptions

1. *Density of the material has been based on 1.5 tons/bcy*
2. *Transportation and disposal is based on 5% overage and a 15% fluff factor. Cost of disposal based on quote from Mark Krening/Waste Management, 08/26/09. Assumes waste is non-hazardous and contains no liquid.*
3. *Loose density and fluff factor will need to be qualified before full scale operation by loading a truck and pup and then weighing it full*
4. *Volume estimates for fill area based on removing top 2 feet of soil.*
5. *Disposal and transport costs based on material going to Waste Management - Riverbend Landfill, in McMinnville, Oregon. Located app. 48 miles away.*
6. *Overall duration has been estimated at 2 weeks to occur within the summer months of June to September*
7. *Volume of dump trailer is estimated at 30 cubic yards.*
8. *Costs for decontamination of trucks, if needed, has not been included.*
9. *It is assumed that Contractor will have to work within the tightly constrained Northwest Pipe Co site, and as such, site activities will impact construction productivy. Productivity reduction was assumed to be 20% of the cost for construction activities that could affect construction productivity.*
10. *The estimate includes costs for construction services only and does not include any costs for additional design work.*
11. *This estimate does not include any costs for third party construction oversight*

Figure 1
Site Location
Northwest Pipe Company
Portland, Oregon



Legend

Northwest Pipe Property Boundary

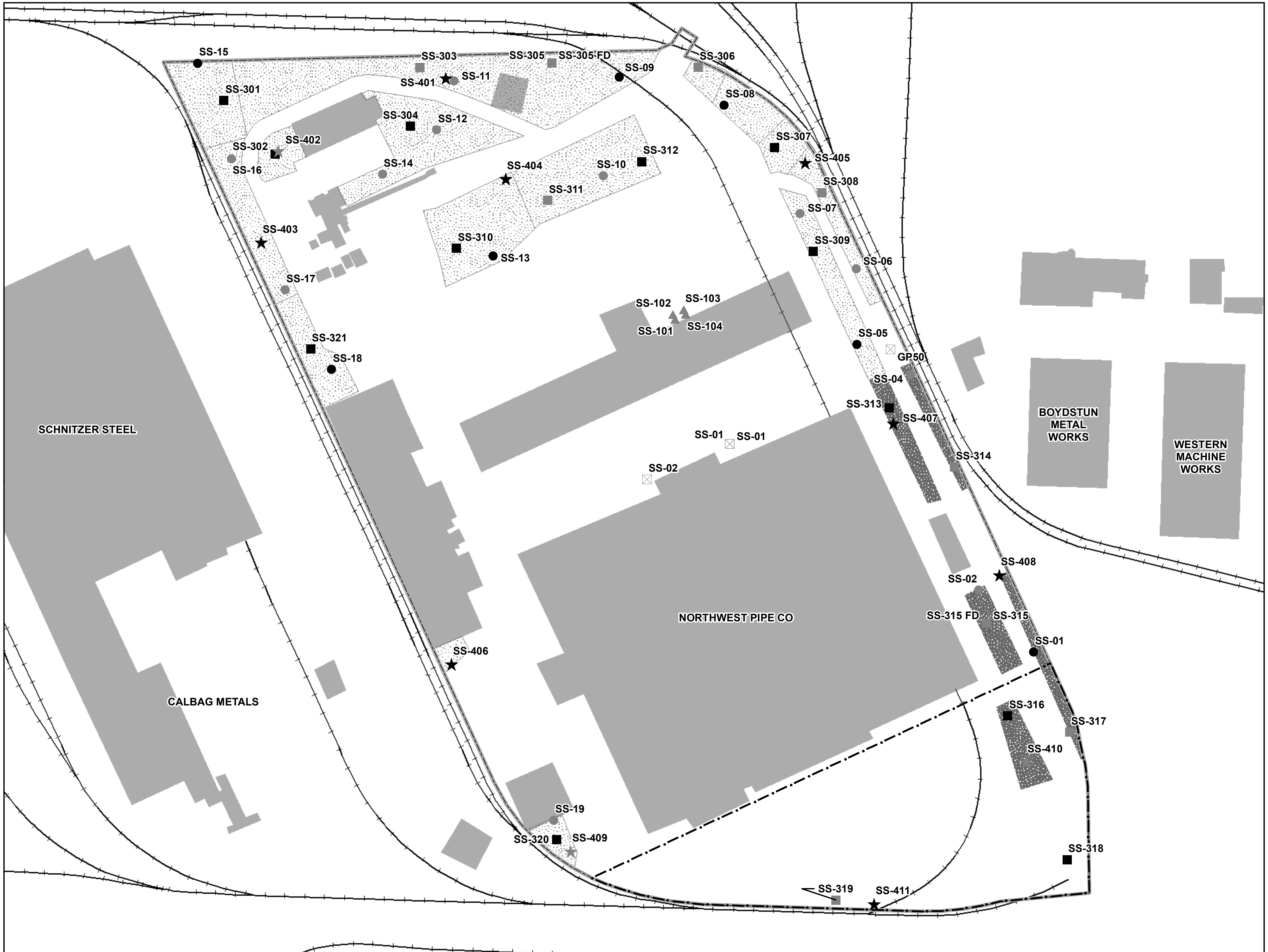
N

0 300 600 900 1,200
Feet

CH2MHILL

\\ROSA\PROJ\NORTHWESTPIPECOMPANY\358932PORTHARBSUP\GIS\MAPFILES\2010\SITELOCATIONMAP.MXD PGRONLI 5/10/2010 09:36:27

Figure 2
Site Map
Northwest Pipe Company
Portland, Oregon



Legend

Surface Soil Sampling

- CH2MHILL 2001, No TPAH Data
- CH2MHILL 2005, No TPAH Data
- CH2MHILL 2006, No TPAH Data
- CH2MHILL 2006, TPAH Data
- CH2MHILL 2007, No TPAH Data
- CH2MHILL 2007, TPAH Data
- CH2MHILL 2009, No TPAH Data
- CH2MHILL 2009, TPAH Data
- Leased Property Boundary
- Northwest Pipe Property Boundary
- Building Footprint
- Railroad Line
- Previously Capped with Pavement
- UnPaved Area

Note: A field duplicate was collected at sample point SS411. The value used for this assessment is an average of the two sample results.

N

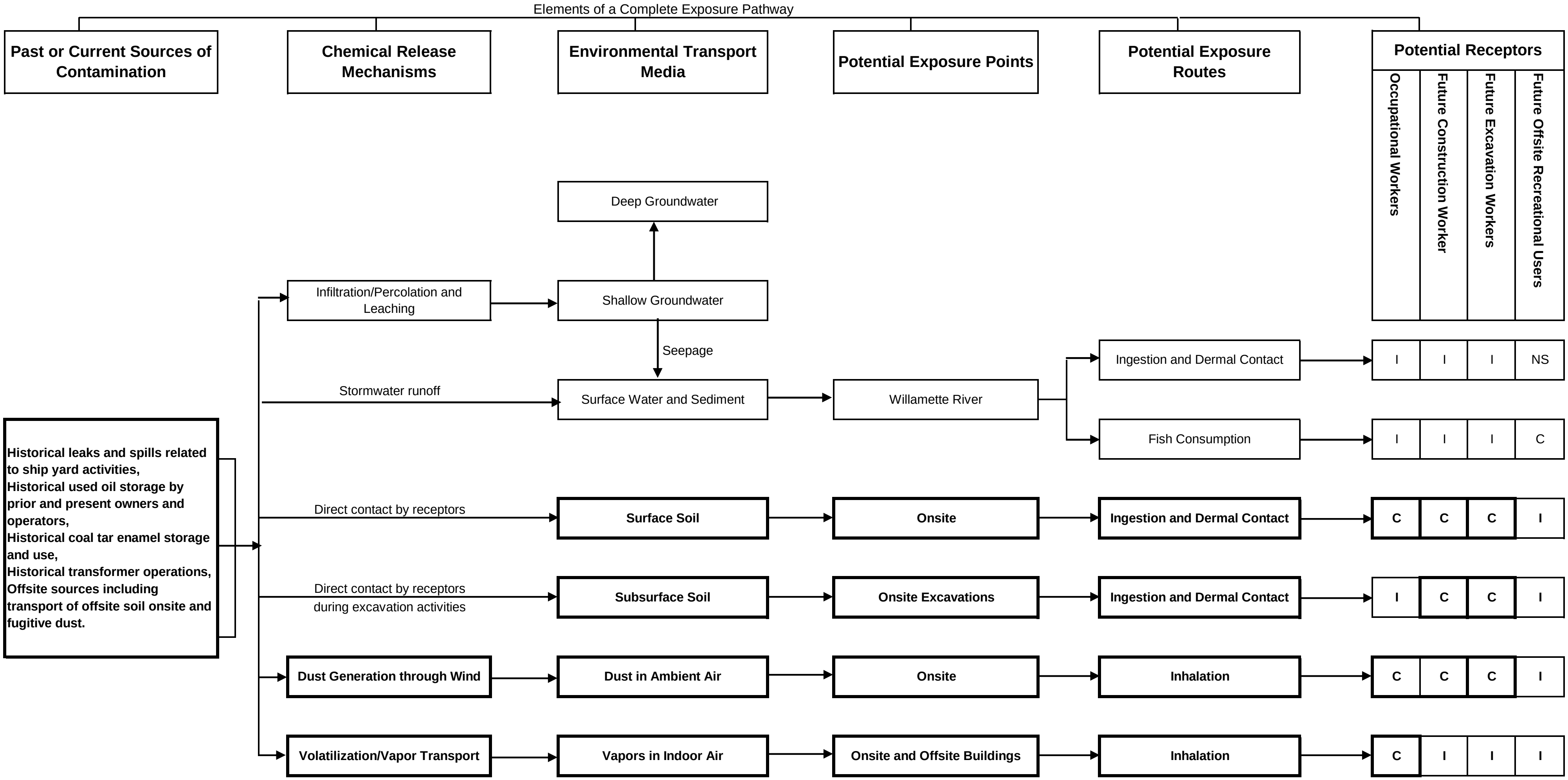
0 40 80 160 240 320

Feet

CH2MHILL

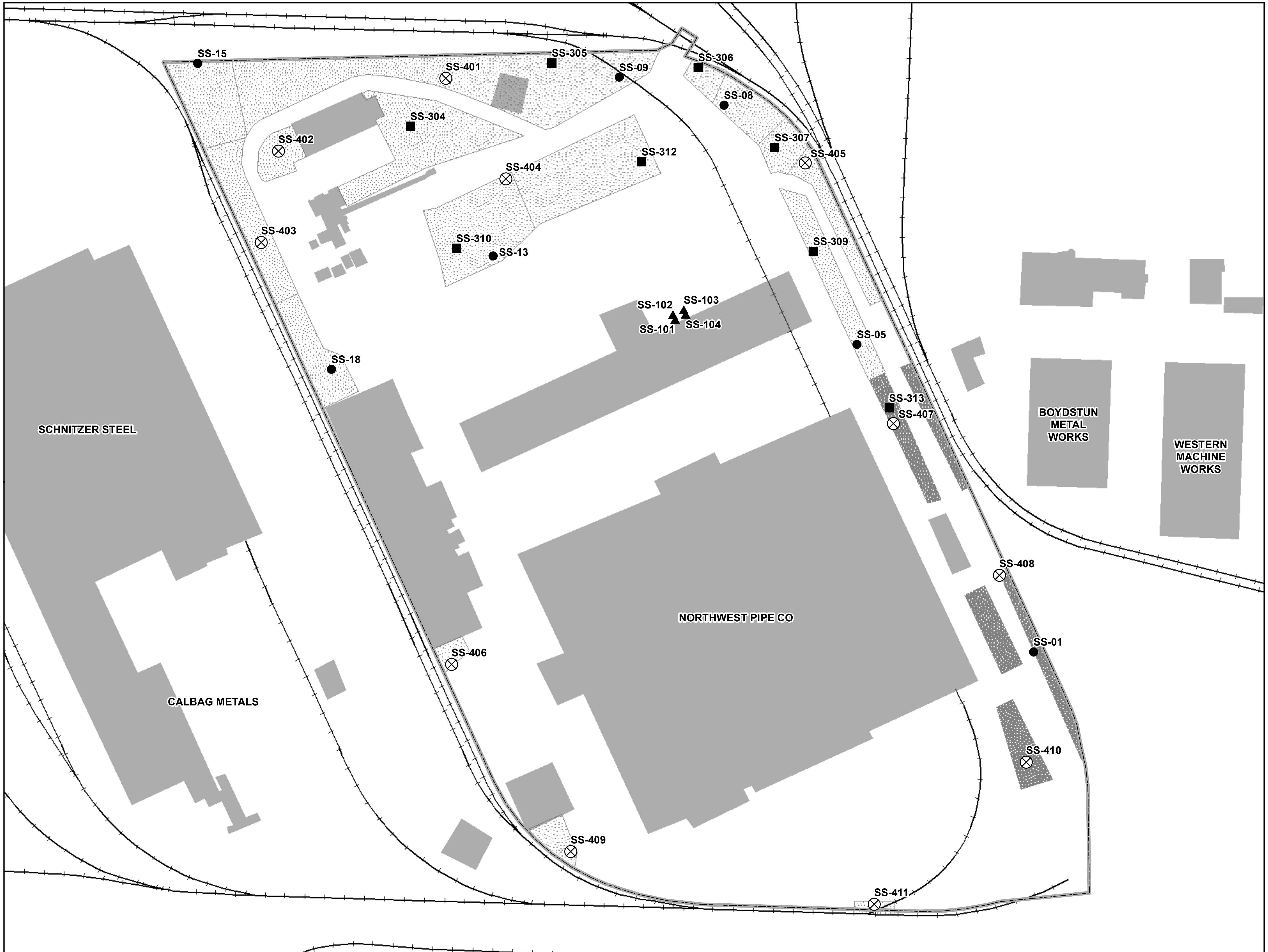
\\ROSA\PROJ\NORTHWESTPIPECOMPANY\358932PORTHARBSUP\GIS\MAPFILES\2010\FIG2_SITEMAP.MXD PGRONLI 5/10/2010 09:51:44

Figure 3
Conceptual Site Model for Human Health Exposure Pathways
Northwest Pipe, Portland, Oregon



Notes:
C = Potentially complete pathway
I = Incomplete pathway
NS = Potentially complete; not significant exposure pathway
Bold pathways indicate those evaluate for the update risk screening in the FFS

Figure 4
Areas To Be Paved
Northwest Pipe Company
Portland, Oregon



Legend

Surface Soil Sampling

- ▲ CH2MHILL 2005
- ● CH2MHILL 2006
- ■ CH2MHILL 2007
- ⊗ CH2MHILL 2009
- Northwest Pipe Property Boundary
- Building Footprint
- Railroad Line
- Previously Capped with Pavement
- Proposed Paved Area

Note: A field duplicate was collected at sample point SS411. The value used for this assessment is an average of the two sample results.

N

0 40 80 160 240 320

Feet

CH2MHILL

\\ROSA\PROJ\NORTHWESTPIPECOMPANY\358932PORTHARBSUP\GIS\MAPFILES\2010\FIG6_TOBEPAVED.MXD PGRONLI 5/10/2010 12:20:03

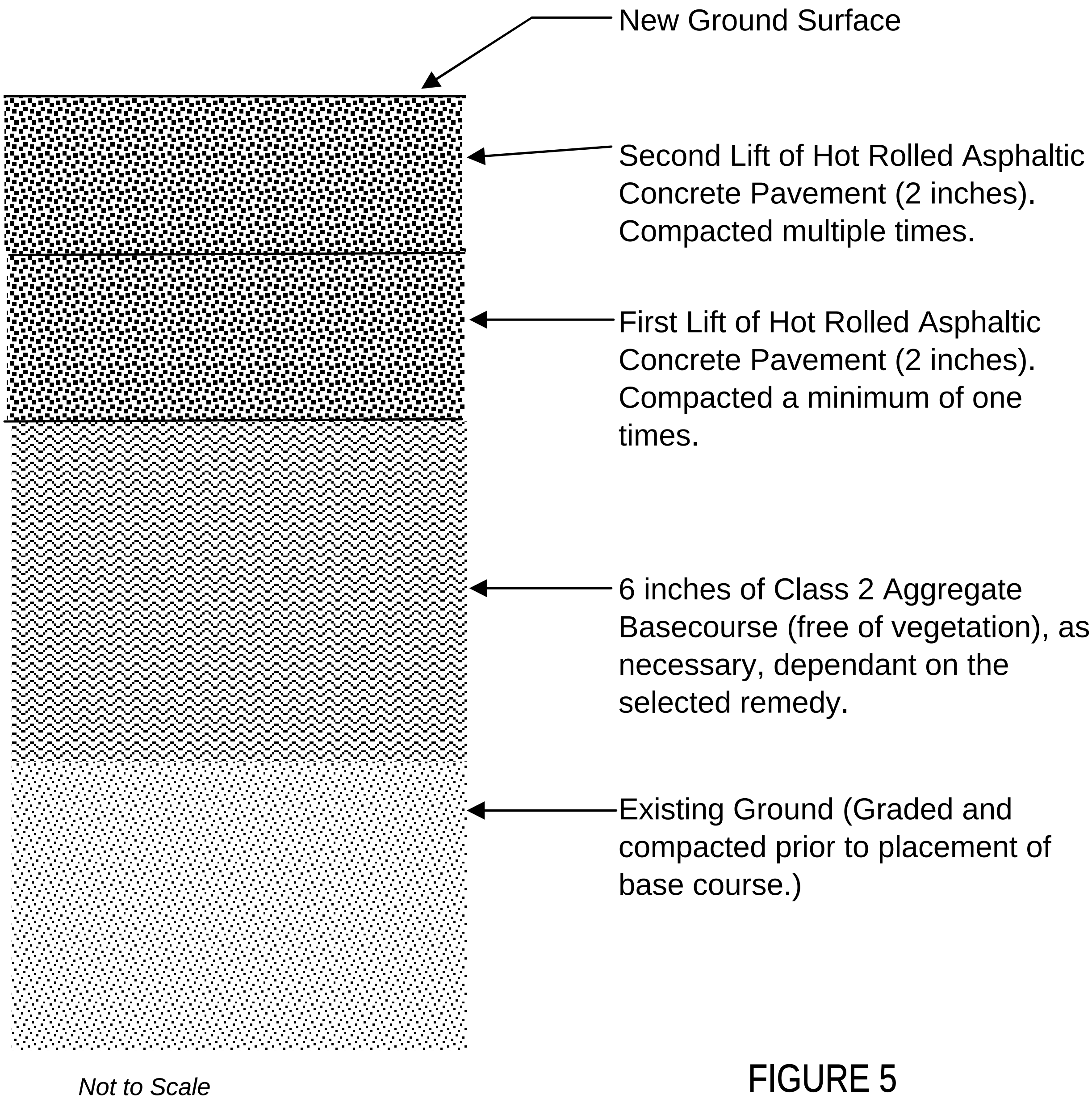
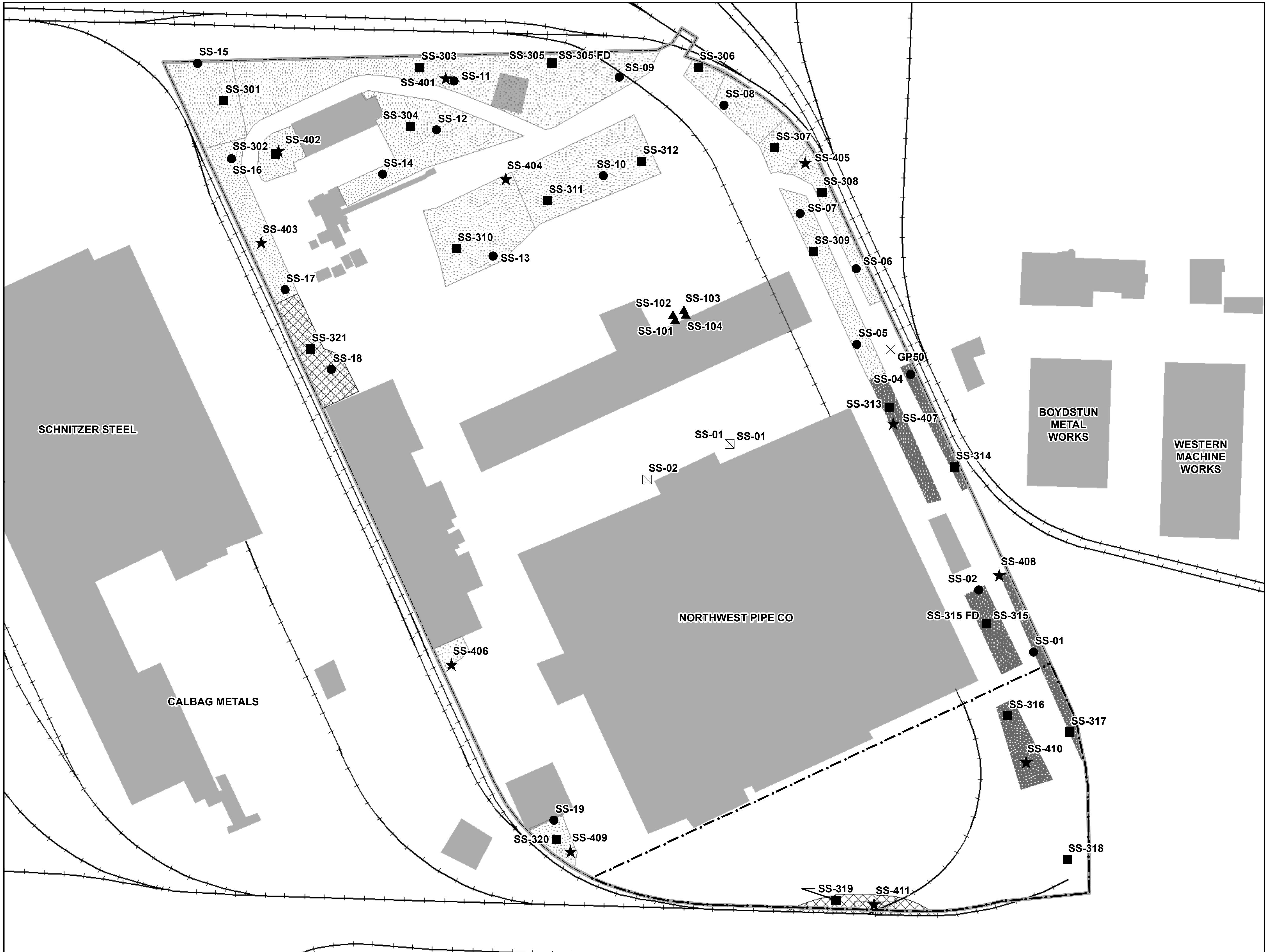


FIGURE 5
Pavement Cross Section
NORTHWEST PIPE COMPANY
PORTLAND, OREGON

CH2MHILL

Figure 6
Hot Spot Removal Areas
Northwest Pipe Company
Portland, Oregon



Legend

Surface Soil Sampling

- CH2MHILL 2001
- CH2MHILL 2005
- CH2MHILL 2006
- CH2MHILL 2007
- CH2MHILL 2009
- Leased Property Boundary
- Northwest Pipe Property Boundary
- Building Footprint
- Railroad Line
- Hot Spot Removal Area
- Previously Capped with Pavement
- UnPaved Area

Note: A field duplicate was collected at sample point SS411. The value used for this assessment is an average of the two sample results.

N

0 40 80 160 240 320
Feet

CH2MHILL

\\ROSA\PROJ\NORTHWESTPIPECOMPANY\358932PORTHARBSUP\GIS\MAPFILES\2010\FIG5_HOTSPOTREMOVAL.MXD PGRONLI 5/10/2010 10:23:29