ATTACHMENT 4 A

Excerpt from Draft Sea Level Rise Vulnerability Assessment

Brisbane

Map: Zone 1

Brisbane has 7 acres of land affected in the baseline scenario, 18 acres in the mid-level, and 261 in the high-end scenario. In the baseline scenario, 1.5 acres of wetlands bordering Highway 101 are inundated, and small portions of the marina are inundated as well, along with one of Brisbane's eight outfalls. In the mid-level scenario, the shoreline begins to flood Highway 101 in a couple locations, and approximately 3 acres of wetlands and 1.3 miles of trails are inundated. Assets proportionally most vulnerable in Brisbane include outfalls, other built shorelines (neither levees nor floodwalls), wetlands, and trails. Recreational assets may be the most affected asset type in Brisbane, but other important infrastructural assets that are at risk, though proportionally low, may still pose significant challenges in a flood event. Nearly 22% of its "other built shorelines" (i.e., built protective shoreline features that are not levees), nearly 13% of its outfalls, and approximately 19% of its wetlands are affected at the mid-level scenario, all of which are assets that may play a role in adapting to sea level rise or coping with flood events when they occur.

In the high-end scenario, Highway 101 becomes overtopped in several locations, and the lagoon is flooded.

*The baseline scenario shows a 1% annual chance flood at mean higher high water; the mid-level scenario shows a 1% annual chance flood plus 3.3 feet of sea level rise; the high-end scenario shows a 1% chance annual flood plus 6.6 feet of sea level rise.

General Information

Land Use, Population, and Parcels	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Land Area (acres)	2,008	0	7	18	261
Population	4,282	0	0	0	0
Population in Vulnerable Communities[1]	1,300	0	0	0	0
Urban Land (acres)	830	0	1	5	66
Agricultural Land (acres)	0	0	0	0	0
Industrial Land (acres)	203	0	0	0	2
Natural Land (acres)	975	0	6	13	193
Residential Parcels[2]	--	0	0	0	0
Commercial Parcels[2]	--	0	2	3	6
Other Parcels[2]	--	0	6	10	68
Parcels with No Data Available[2]	--	0	0	0	74
Assessed Value of All Parcels at Risk ($ in Millions)[2]	--	$0	$53	$71	$172

[1]Individuals with characteristics that make them more vulnerable to flooding and other natural disasters; measured at the census block level.

[2]Parcels were only inventoried in the hazard zone.

Natural Assets

Asset Type	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Beaches (miles)	0.0	0.0	0.0	0.0	0.0
Eelgrass Habitat (acres)	0.0	0.0	0.0	0.0	0.0
Inland Freshwater and Saltwater Features (acres)	113.2	0.0	0.0	0.0	112.0
Kelp Habitat (acres)	0.0	0.0	0.0	0.0	0.0
Streams (miles)	0.0	0.0	0.0	0.0	0.0
Surfgrass Habitat (miles)	0.0	0.0	0.0	0.0	0.0
Wetlands (acres)	15.1	0.0	1.5	2.9	14.2

Class 4 Assets

Asset Type	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Airports	0	0	0	0	0
Communications Towers	32	0	0	1	2
Electric Substations	1	0	0	0	0
Emergency Operations Centers	0	0	0	0	0
Emergency Shelter Sites	2	0	0	0	0
Fire Stations	1	0	0	0	1
Hazardous Material Sites	34	0	0	0	1
Health Care Facilities (emergency)	0	0	0	0	0
Highway and Railway Bridges	4	0	0	0	1
Highways (miles)	7.1	0.0	0.0	0.3	3.6
Levees and Floodwalls (miles)	0.0	0.0	0.0	0.0	0.0
Natural Gas Pipelines (miles)	9.2	0.0	0.0	0.0	2.2
Natural Gas Storage	4	0	0	0	0
Other Built Shorelines (miles)	7.3	0.0	0.4	1.6	5.3
Police Stations	1	0	0	0	0
Power Plants	0	0	0	0	0
Refined Product Terminals	1	0	0	0	0
Solid Waste Facilities and Closed Landfills	3	0	0	0	0

Class 3 Assets

Asset Type	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Caltrans Maintenance Facilities	0	0	0	0	0
Health Care Facilities (inpatient)	0	0	0	0	0

Human Services Agency Partner Facilities	0	0	0	0	0
Jails	0	0	0	0	0
Oil, Gas, and Geothermal Wells	0	0	0	0	0
Outfalls	8	0	1	1	3
Ports	0	0	0	0	0
Rail (miles)	5.4	0.0	0.0	0.0	1.7
Rail Stations	1	0	0	0	1
Roads (local) (miles)	29.5	0.0	0.0	0.0	1.2
Schools	2	0	0	0	0
Senior Centers	0	0	0	0	0
Storm Drains (miles)	9.4	0.0	0.0	0.0	0.4
Stormwater Pump Stations[3]	-	-	-	-	-
Transmission Lines (miles)	8.2	0.0	0.0	0.0	0.0
Transmission Towers	55	0	0	0	0
Underground Chemical Storage Tanks	2	0	0	0	0
Wastewater Pump Stations[3]	-	-	-	-	-
Wastewater Treatment Plants	0	0	0	0	0

[3]Data not available for every city and town in the project area.

Class 2 Assets

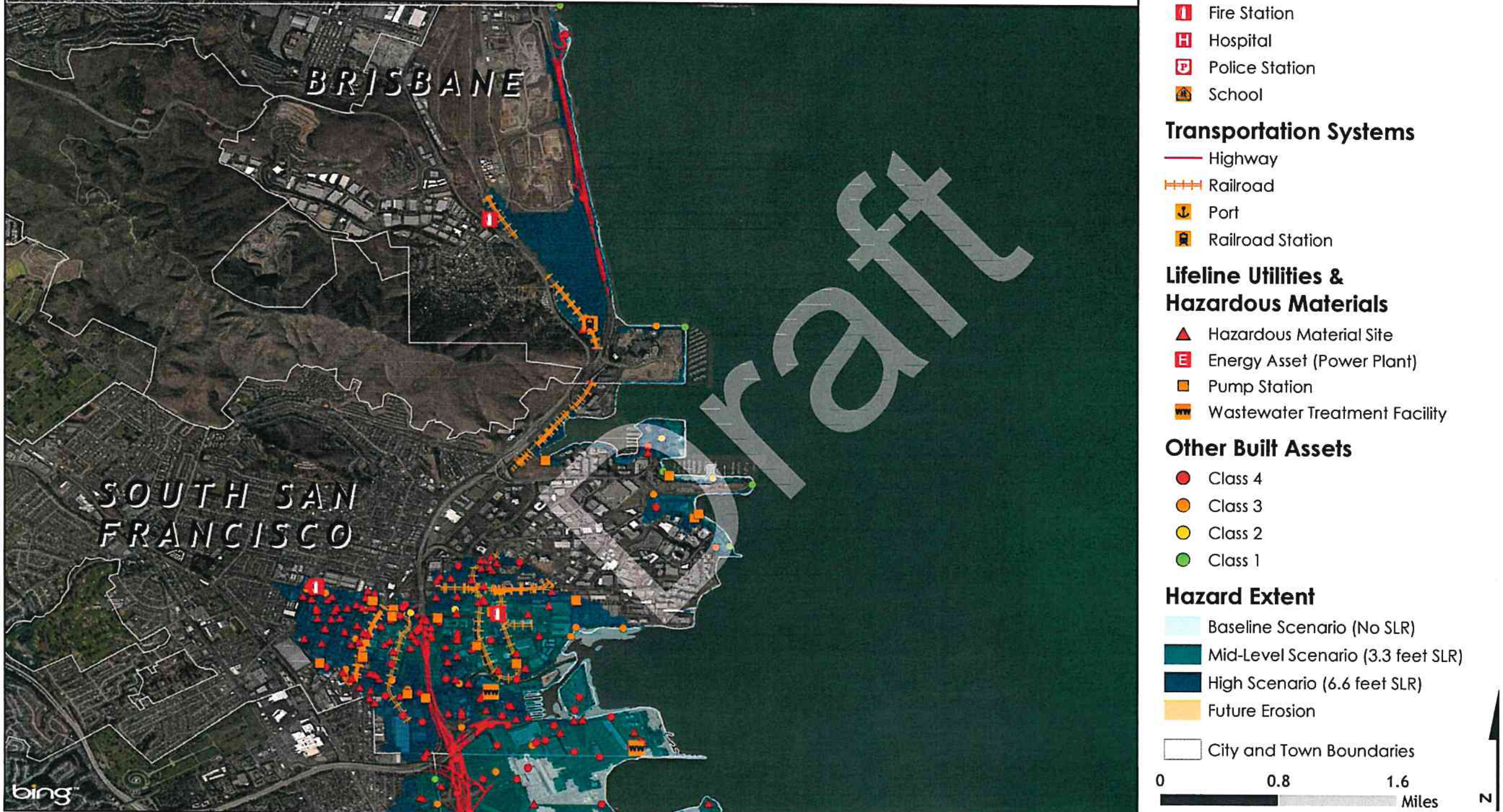
Asset Type	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Buildings with Affordable Rental Units	1	0	0	0	0
Health Care Facilities (outpatient)	0	0	0	0	0
Marinas	1	0	1	1	1
Mobile Home Parks	2	0	0	0	0

Class 1 Assets

Asset Type	Total	Erosion Scenario	Baseline Scenario	Mid-level Scenario	High-end Scenario
Boat Launches	0	0	0	0	0
Fishing Piers	1	0	0	1	1
Parks	9	0	0	0	1
Salt Ponds and Crystallizers	0	0	0	0	0
Trails (miles)	5.7	0.0	0.4	1.3	2.8

Built Asset Exposure Zone 1:

Brisbane, South San Francisco

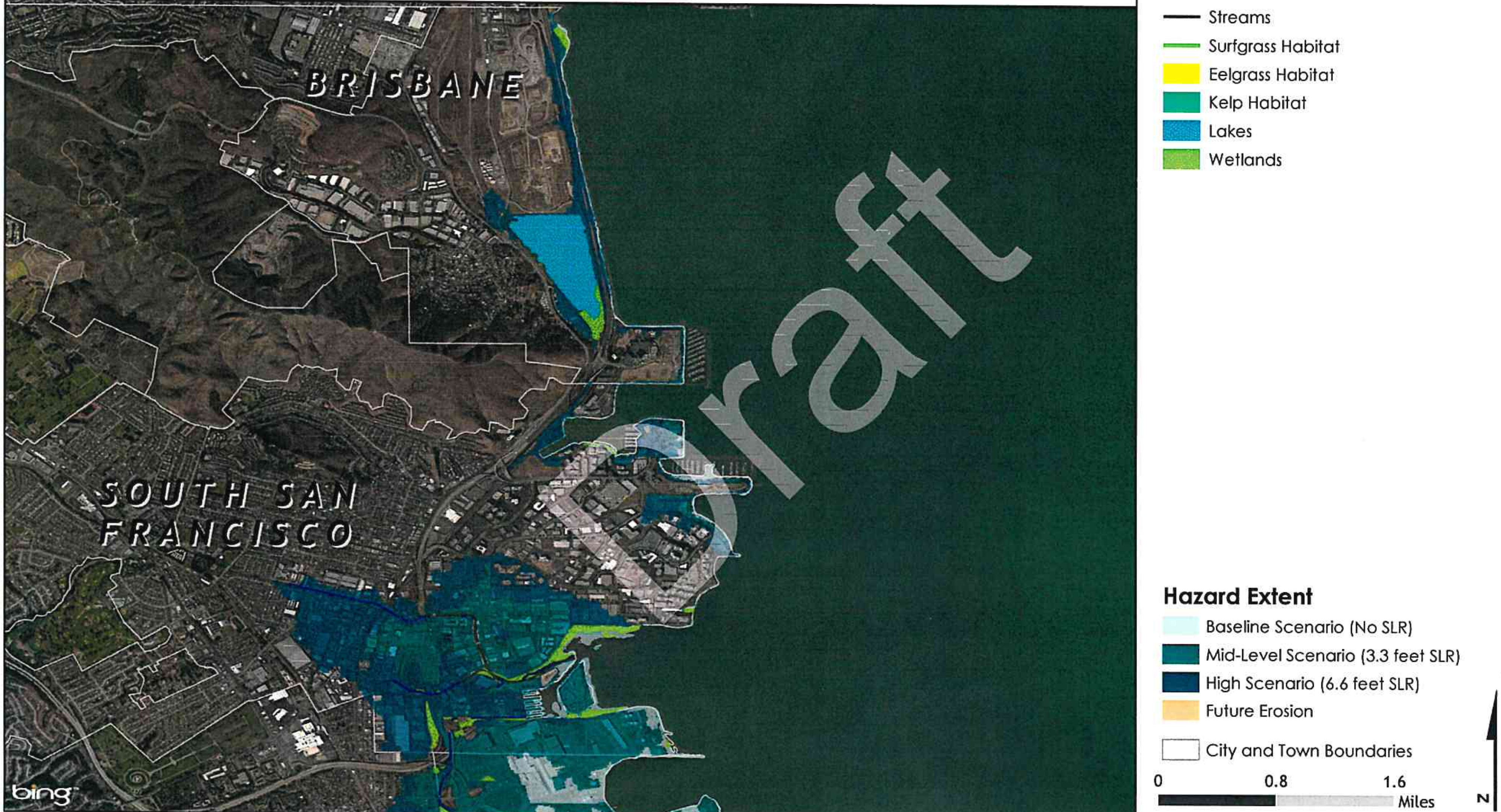


This draft map is subject to change. It is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of inundation and coastal flooding due to specific sea level rise and storm surge scenarios. This map is not detailed to the parcel-scale and should not be used for navigation, permitting, regulatory, or other legal uses. Flooding due to sea level rise and storm surge is possible in areas outside of those predicted, and even the best predictions cannot guarantee the safety of an individual or structure. Nor does this map model flooding from riverine, surface water flooding from rainfall-runoff events, or other sources. The contributors and sponsors of this product do not assume liability for any injury, death, property damage, or other effects of flooding. All underlying data for the inundation layers is from the Our Coast Our Future tool and the erosion layers are from the Pacific Institute. The erosion scenario does not account for shoreline protection. For the inundation scenarios, although care was taken to capture relevant topographic features and coastal structures that may impact coastal inundation, it is possible that structures may not be fully represented.

Natural Asset Exposure

Zone 1: **Appendix B: Asset Exposure Maps**

Brisbane, South San Francisco



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ATTACHMENT 4 B

How to Select an Effective Vapor Retarder/Barrier Guideline

HOW TO
SELECT AN EFFECTIVE VAPOR RETARDER/BARRIER
GUIDELINE

RAVEN
ENGINEERED FILMS

STRAIGHT TALK ABOUT WATER VAPOR RETARDERS/BARRIERS.

The proper water vapor retarder/barrier, when correctly installed, will provide an effective and economical method of limiting water vapor from traveling upward through a concrete slab-on-grade or below the exterior grade. Without the proper water vapor retarder/barrier, many problems can occur. Excessive moisture will adversely affect moisture-impermeable floor finishes causing breakdown of adhesion, warping or peeling, rotting of carpet, buckling and decay of wood floors, offensive odors and fungi growth.

To avoid these and other problems, it is extremely important to do your homework when choosing an effective vapor retarder/barrier. We have developed this guide to provide information which will help you choose the best vapor retarder/barrier, at the best value.

BUCKLED FLOOR COVERING

THE TRUTH ABOUT VAPOR RETARDERS/BARRIERS.

TRUTH 1 No two water vapor retarders/barriers are created equal. The vapor retarder/barrier you select should be manufactured from high-grade raw materials that are consistent in quality, unlike common construction grades of 4, 6 or 10 mil polyethylene. Construction grade films (known as C&A or visqueen) are typically produced with very low grades of polyethylene resin and a very high percentage of "post consumer" recycled materials. The numerous heat cycles in the reprocessing of recycled materials, combined with the varied types of resin used, cause inconsistencies in physical strength and permeability. While this commodity film serves a purpose in temporary construction and agricultural applications, it is not designed to provide ongoing protection against unwanted moisture. Film characteristics such as low strength and poor resistance to decay should be of major concern.

TRUTH 2 A long-term vapor retarder/barrier must maintain life long integrity by resisting decay, attack by moisture, organisms in the soil and chemicals. As mentioned above, beware of vapor retarders/barriers manufactured with "post consumer" recycled resins (C&A Poly or Visqueen) which can degrade from chemicals in the soil. Paper laminates can degrade from moisture attack.

TRUTH 3 Moisture problems associated with a vapor retarder/barrier installed under the concrete slab-on-grade are often traced to punctured or torn water vapor retarders/barriers. Damage due to construction traffic during installation, can be detrimental to the performance of the vapor retarder/barrier. Physical characteristics such as high puncture resistance and tensile strength, along with low-moisture vapor permeability, are vital attributes of a vapor retarder/barrier. These physical characteristics are well quantified in ASTM E-1745-11 and are outlined in this guide.

TRUTH 4 When specifying a water vapor retarder/barrier, designed for use in under concrete slab applications, insist the supplier meets the most stringent ASTM standard applying to vapor retarders, ASTM E-1745-11 for "Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs". It assures minimum values are met regarding tensile strength and puncture resistance, along with the maximum allowable water vapor permeance. ASTM E-1745-11 separates these properties into three performance classes: Class A, B & C. (See chart on following page.)

SELECTING AN EFFECTIVE WATER VAPOR RETARDER/BARRIER FOR YOUR PROJECT.

Before you buy or specify a water vapor retarder/barrier, separate what's "nice" to know, from what must be known to make your decision. The process of selecting a vapor retarder/barrier includes two key steps:

STEP 1 Selecting a water vapor retarder/barrier best suited for your application.

(Note: Sites containing a potential risk for gas migration through the slab-on-grade or Brownfield sites; please contact Raven Industries for further information on our underslab gas barriers.)

A vertical wall vapor retarder/barrier may demand a more puncture resistant barrier because of design conditions such as the type of backfill material and the backfill method used. Another condition to consider is the type of compacted sub-grade used on a slab-on-grade or a sub-grade application. If sharp crushed rock is specified because of availability, or design, a more puncture-resistant vapor retarder/barrier will be required in addition to a ½" layer of fine compactible fill. Typically, river-run (washed rock) will cause less damage to the retarder/barrier. In general, more demanding conditions such as high foot traffic and stress resulting from the placement of concrete may require a Class A or B (ASTM E-1745-11) vapor retarder. Please refer to the chart qualifying each of our vapor retarders/barriers.

STEP 2 Insist the vapor retarder/barrier you're specifying meets ASTM E 1745-11 performance requirements! Ask yourself during the selection process:

- Has the vapor retarder/barrier been tested for resistance to deterioration from contact with soil and still maintains a 0.1 Perm or less (ASTM E 154 Section 13)? In many cases, an engineer will prefer a perm rating that is even lower then the recommended value to maximize protection from moisture transmission.
- Does the vapor retarder/barrier meet the minimum puncture strengths required of an A, B or C classification? Puncture strength is a very critical factor in determining if a vapor retarder/barrier is capable of withstanding installation stress.
- Does the manufacturer provide proper certification of independent testing, correct classification and product labeling identifying class A, B or C?
- Have you determined what classification you will require in order to meet your customer's performance expectations?

VAPOR RETARDER COMPARISON - BASED ON ASTM E-1745-11 REQUIREMENTS

PRODUCT / CLASSIFICATION	WATER VAPOR PERMEANCE (E 154, Section 7 or F 1249), max	TENSILE STRENGTH (E 154, Section 9), min	PUNCTURE RESISTANCE (D 1709, Method B), min	CLASS A	CLASS B	CLASS C
Class A Requirement	0.10 perms	45.0 lb/in	2200 grams	•		
Class B Requirement	0.10 perms	30.0 lb/in	1700 grams		•	
Class C Requirement	0.10 perms	13.6 lb/in	475 grams			•
Raven VaporBlock® 15	0.0057 perms	78.0 lb/in	3300 grams	•	•	•
Raven VaporBlock® 10	0.0146 perms	52.0 lb/in	2600 grams	•	•	•
Raven VaporBlock® 6	0.090 perms	32.0 lb/in	1500 grams			•

RAVEN INDUSTRIES VAPOR RETARDERS/BARRIERS CONTROL MOISTURE MIGRATION IN BUILDING PROJECTS.

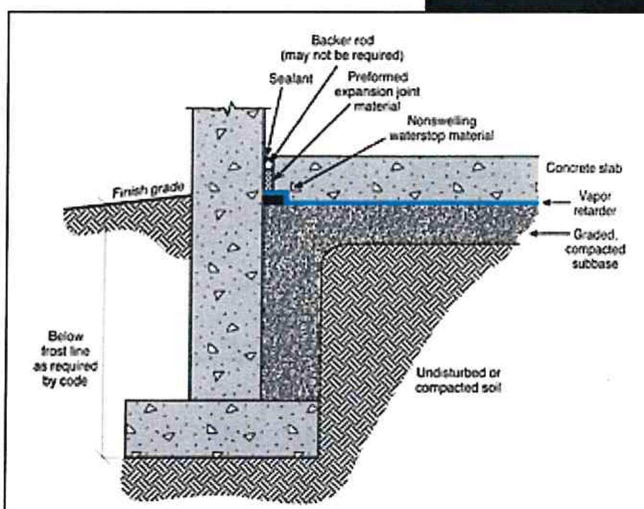
When guarding against moisture problems, why use a vapor retarder/barrier that produces watered-down results? Raven vapor retarders/barriers are a time-proven, cost effective means of controlling moisture within the building interior, building components and materials within the structure. Constructed from high-strength polyethylene, Raven vapor retarders/barriers are designed to help insure quality construction and energy savings in building projects.

ALL RAVEN VAPOR RETARDERS MEET OR EXCEED ASTM E-1745 REQUIREMENTS FOR WATER VAPOR RETARDERS USED IN CONTACT WITH SOIL OR GRANULAR FILL UNDER CONCRETE SLABS.

RAVEN UNDERSLAB BARRIERS CONTROL MOISTURE & GAS MIGRATION IN:

UNDER CONCRETE SLAB
(Moisture Vapor Retarder/Barrier)

Raven vapor retarders/barriers protect your building's interior and flooring system from moisture migration through the slab. Developed to meet or exceed the most stringent "Standard for Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs" (ASTM E-1745-11), Raven water vapor retarders/barriers meet or exceed Class A, B or C performance values.



CONCRETE SLAB ON GRADE: OPTIMUM RELATIONSHIP OF VAPOR RETARDER/BARRIER COMPONENTS

UNDER CONCRETE SLAB
(Gas and Moisture Retarder/Barrier)

In addition to protection from moisture migration, Raven manufactures gas/moisture barriers designed to resist radon, methane and a broad range of harmful VOCs from migrating through the concrete slab. These barriers are typically used in conjunction with a passive or active control system extending across the entire building including floors and crawl spaces. These barriers meet the requirements of ASTM E-1745-11 Class A, B or C.

The original diagram on this page was reprinted with permission by the Portland Cement Association. Reference: Kanare, Howard M., Concrete Floors and Moisture, EB119, Portland Cement Association, Skokie, Illinois, and National Ready Mixed Concrete Association, Silver Spring, Maryland, USA, 2008, 176 pages.

RAVEN
VAPOR/GAS BARRIERS.

VAPORBLOCK® 6, 10 & 15
UNDERSLAB VAPOR RETARDER/BARRIER

C	Part # VB 6 (6 mil Blue)
A B C	Part # VB 10 (10 mil Blue)
A B C	Part # VB 15 (15 mil Blue/White)

VaporBlock® 6, 10 & 15 are high performance underslab vapor retarders/barriers designed to retard moisture migration through concrete slabs-on-grade. **VaporBlock®** is made from state-of-the-art polyethylene resins that provide superior physical and performance properties that far exceed ASTM E-1745-11 (Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs) Class A, B and C requirements. See chart listing requirements and results on page 3.

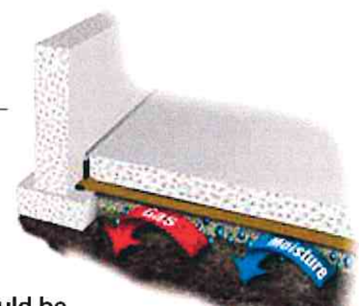
- RESISTS ATTACK BY ORGANISMS IN THE CONTACTING SOIL.
- GREATLY REDUCES DAMAGING MOISTURE MIGRATION THROUGH WALLS AND UNDER CONCRETE SLABS.
- RESISTS TEARING AND PUNCTURE DURING THE INSTALLATION PHASES.
- AVAILABLE IN CONVENIENT SIZES ALLOWING FOR FAST AND EASY INSTALLATION & MINIMIZES FIELD SEAMS.
- MEETS OR EXCEEDS ASTM E 1745 PERFORMANCE CLASSES.
- EXCELLENT "PERM RATINGS".

VAPORBLOCK® PLUS™ 20
UNDERSLAB MOISTURE AND GAS BARRIER

A B C | Part # VBP 20 (20 mil White/Gold)

VaporBlock® Plus™ is a seven-layer co-extruded barrier made from state-of-the-art polyethylene and barrier resins to provide unmatched impact strength as well as superior resistance to gas and moisture transmission. **VaporBlock Plus** is a highly resilient underslab / vertical wall barrier designed to restrict naturally occurring gases and is more than 50 times less permeable than typical high performance polyethylene vapor retarders against methane, radon and other harmful VOCs.

VaporBlock Plus can be installed as part of a passive or active control system extending across the entire building including floors, walls and crawl spaces. When installed as a passive system it is recommended to include a ventilated system with sump(s) that could be converted to an active control system with properly designed ventilation fans.



VaporBlock Plus works to protect your flooring and other moisture-sensitive furnishings in the building's interior from moisture and water vapor migration, greatly reducing condensation, mold and degradation.

RAVEN UNDERSLAB VAPOR / GAS BARRIERS

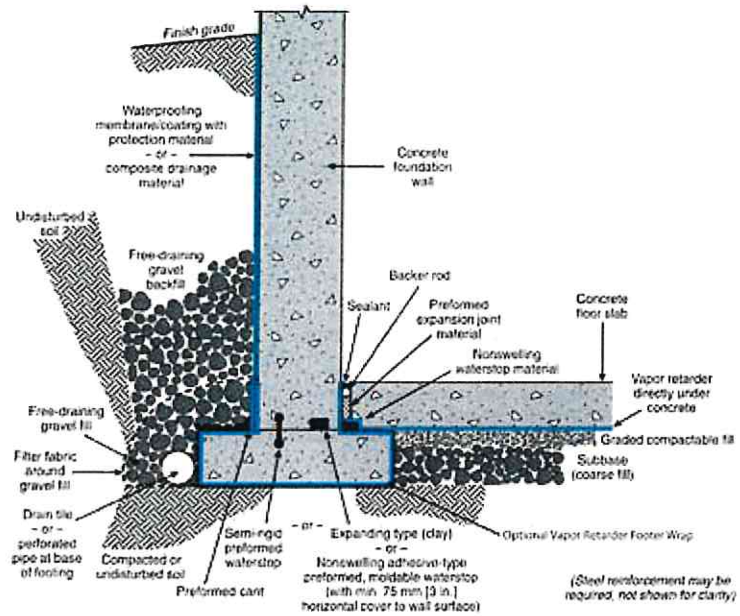
UNDERSLAB VAPOR / GAS BARRIERS
INSTALLATION GUIDELINES

Visit our website for current technical data sheets as well as detailed installation guidelines at www.vaporblock.com and click on the appropriate link under the left menu.

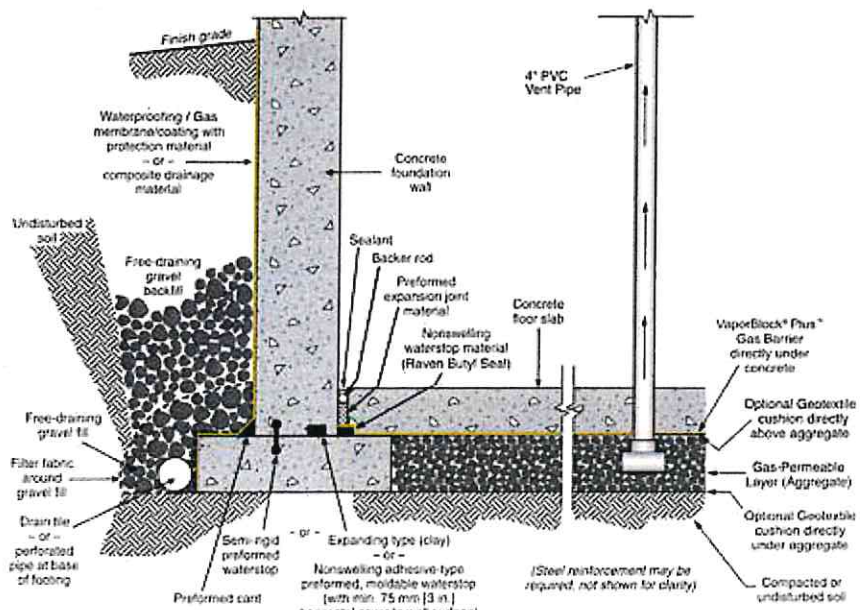
Note: Please refer to ASTM E 1643 (Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs) and the appendixes that accompany this standard to provide additional installation information.

Please follow all architectural drawings/instructions and conform to all applicable local, state and federal regulations and laws pertaining to residential and commercial building construction.

UNDERSLAB VAPOR RETARDER/BARRIER



UNDERSLAB MOISTURE AND GAS BARRIER



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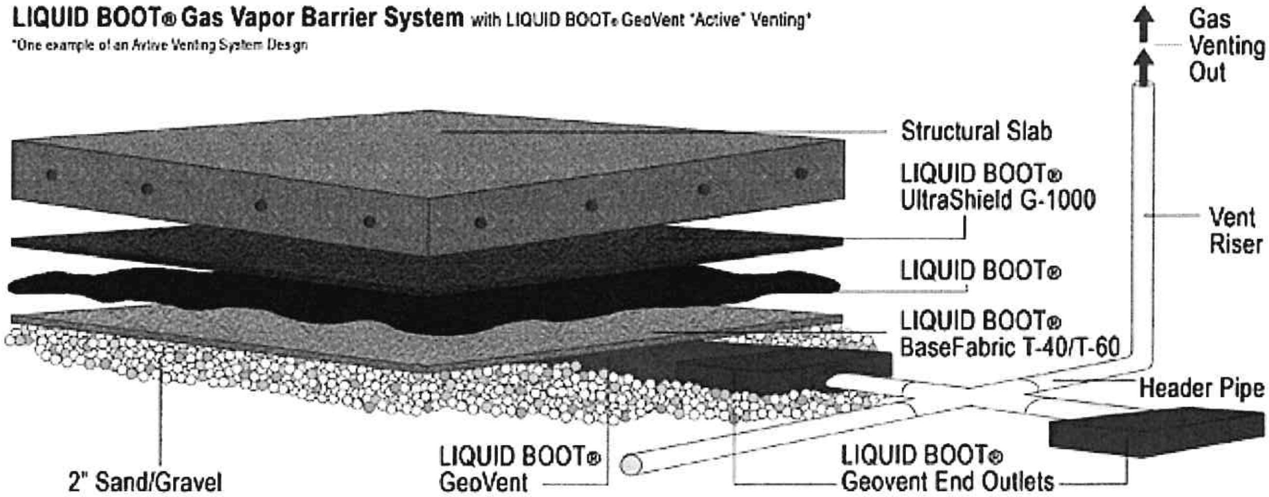
Raven Industries, Inc. • P.O. Box 5107 • Sioux Falls, SD 57117-5107
Phone: 605-335-0174 • Fax: 605-331-0333 • Web Site: www.vaporblock.com
800-635-3456


LIQUID BOOT® Gas Vapor Barrier System with LIQUID BOOT® GeoVent "Active" Venting*
*One example of an Active Venting System Design
Gas Venting Out
Structural Slab
LIQUID BOOT® UltraShield G-1000
Vent Riser
LIQUID BOOT®
LIQUID BOOT® BaseFabric T-40/T-60
Header Pipe
2" Sand/Gravel
LIQUID BOOT® GeoVent
LIQUID BOOT® Geovent End Outlets

ATTACHMENT 4 C

Disposal Site Postclosure Land Use Regulation

LEA Advisory #51: Attachment 2

Disposal Site Postclosure Land Use Regulation

Title 27, Division 2, Subdivision 1, Chapter 3, Subchapter 5, Article 2

§21190. CIWMB Postclosure Land Use

(a) Proposed postclosure land uses shall be designed and maintained to:

(1) protect public health and safety and prevent damage to structures, roads, utilities and gas monitoring and control systems;

(2) prevent public contact with waste, landfill gas and leachate; and

(3) prevent landfill gas explosions.

(b) The site design shall consider one or more proposed uses of the site toward which the operator will direct its efforts, or shall show development as open space, graded to harmonize with the setting and landscaped with native shrubbery or low maintenance ground cover.

(c) All proposed postclosure land uses, other than non-irrigated open space, on sites implementing closure or on closed sites shall be submitted to the EA, RWQCB, local air district and local land use agency. The EA shall review and approve proposed postclosure land uses if the project involves structures within 1,000 feet of the disposal area, structures on top of waste, modification of the low permeability layer, or irrigation over waste.

(d) Construction on the site shall maintain the integrity of the final cover, drainage and erosion control systems, and gas monitoring and control systems. The owner or operator shall demonstrate to the satisfaction of the EA that the activities will not pose a threat to public health and safety and the environment. Any proposed modification or replacement of the low permeability layer of the final cover shall begin upon approval by the EA and the RWQCB.

(e) Construction of structural improvements on top of landfilled areas during the postclosure period shall meet the following conditions:

(1) automatic methane gas sensors, designed to trigger an audible alarm when methane concentrations are detected, shall be installed in all buildings;

(2) enclosed basement construction is prohibited;

(3) buildings shall be constructed to mitigate the effects of gas accumulation, which may include an active gas collection or passive vent systems;

(4) buildings and utilities shall be constructed to mitigate the effects of differential settlement. All utility connections shall be designed with flexible connections and utility collars;

(5) utilities shall not be installed in or below any low permeability layer of final cover;

(6) pilings shall not be installed in or through any bottom liner unless approved by the RWQCB;

(7) if pilings are installed in or through the low permeability layer of final cover, then the low permeability layer must be replaced or repaired; and

(8) periodic methane gas monitoring shall be conducted inside all buildings and underground utilities in accordance with §20933 of Article 6, of Subchapter 4 of this Chapter.

(f) The EA may require that an additional soil layer or building pad be placed on the final cover prior to construction to protect the integrity and function of the various layers of final cover.

(g) All on-site construction within 1,000 feet of the boudary of any disposal area shall be designed and constructed in accordance with the following, or in accordance with an equivalent design which will prevent gas migration into the building, unless an exemption has been issued.

(1) a geomembrane or equivalent system with low permeability to landfill gas shall be installed between the concrete floor slab of the building and subgrade;

(2) a permeable layer of open graded material of clean aggregate with a minimum thickness of 12 inches shall be installed between the geomembrane and the subgrade or slab;

(3) a geotextile filter shall be utilized to prevent the introduction of fines into the permeable layer;

(4) perforated venting pipes shall be installed within the permeable layer and shall be designed to operate without clogging;

(5) the venting pipe shall be constructed with the ability to be connected to an induced draft exhaust system;

(6) automatic methane gas sensors shall be installed within the permeable gas layer, and inside the building to trigger an audible alarm when methane gas concentrations are detected; and

(7) periodic methane gas monitoring shall be conducted inside all buildings and underground utilities in accordance with Article 6, of Subchapter 4 of this Chapter (§20920 et seq.).

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LEA Advisories, http://www.calrecycle.ca.gov/LEA/Advisories/
Martin Perez: Martin Perez (916) 323-0834

ATTACHMENT 4 D

Risk Management at a Browfields Site: A Case Study in Long-Term Stewardship

Risk management at a brownfields site: a case study in long-term stewardship

L. Feldman
Geomatrix Consultants, Inc., Oakland, California, United States

Abstract

A retail shopping mall was created from a former manufacturing facility located on 154 acres in a rapidly urbanizing environment. Implementing a risk-based approach to address residual pollutants in the soil and groundwater for this "Brownfield" redevelopment was a key factor for the project's economic feasibility. Regulatory requirements for the project approval included soil and groundwater assessment, groundwater monitoring, limited soil and groundwater cleanup, and the full assessment and management of the residual risks posed to future site users. These users included construction workers, maintenance workers, retail employees and customers at the shopping mall. A Site Management Plan, or SMP, acceptable to the regulatory agency, was developed and implemented to manage the residual risks to the site's users after the remediation project was completed. The regulatory agency accepted the concept of leaving properly managed residual concentrations of pollutants in place in the site's soil and groundwater provided the SMP was implemented in perpetuity, or until such time that natural attenuation remediated the residual pollutants to levels where residual risks were low enough to permit unrestricted use of the site. This paper describes the functional elements of risk management contained in the SMP and examines the history of SMP implementation through the presentation of several case studies. These case studies illustrate the benefits of a properly developed and implemented SMP. Case studies for this site as described in this paper include subsequent property transfers of the shopping mall, the discoveries of affected soil within the mall footprint during the anticipated future changes in retail space allocations and space usage, and the efficient management of polluted soil during the anticipated construction of additions to the retail operations within the site.
Keywords: risk management, site management plan, sustainable brownfields projects.

Brownfield Sites II, A. Donati, C. Rossi & C. A. Brebbia (Editors)

1 Introduction

A former vehicle assembly plant in the San Francisco Bay area of California was converted into a retail shopping center in the mid-1990's using a combination of environmental monitoring and cleanup as well as site risk assessment and risk management tools. This brownfields redevelopment property was affected by chemicals in soil and groundwater from past activities and was also affected by chemicals in groundwater due to migration from nearby affected sites. With this site use transformation, this "brownfields" redevelopment project resulted in the short-term cost-effective combination of environmental restoration and property redevelopment. However, long-term care was required by the approving government agency to assure that the residual chemicals in soil and groundwater do not cause future adverse impacts to site maintenance and construction workers, shoppers, and site retail employees. This paper presents a summary of the activities that resulted in regulatory approval to leave residual chemicals in soil and groundwater at the site, presents the elements of the required site management plan developed specifically for the site, and presents a number of case studies for the site where the site management plan was eventually successfully implemented assuring a long-term effective solution to residual chemicals remaining at the site.

2 Site setting and history

The retail shopping center is located on a parcel originally 154 acres in size that was formerly used as a railroad yard, a materials storage facility, and a vehicle assembly facility. During this historic site usage chemicals consisting mainly of petroleum hydrocarbons were released to the environment from two large fueling areas. The facility also utilized approximately 100 sumps and pits containing a wide range of chemicals and paints. Additionally, data from groundwater monitoring wells at the site revealed that chlorinated volatile organic chemicals had migrated from two nearby facilities, sources located up-gradient of the site.

The site is located in the San Francisco Bay lowlands area along the bay margins. As such, the terrain is relatively flat and gently sloping towards the bay located a few miles away. Ground elevations vary from approximately 25 to 45 feet mean sea level. Based on the results of subsurface investigations, the site was determined to be underlain by a complex sequence of heterogeneous and laterally discontinuous deposits of clay, silt, sand, and gravel to at least fifty feet below ground surface. The sediments underlying the site are predominantly fine grained. Based on the results of monitoring some 180 groundwater locations over a twelve year period, the petroleum hydrocarbons and chlorinated volatile organic chemicals found in the groundwater underlying the site were determined to be located in the upper water bearing zones, to a depth of twenty-five feet.

The lead California regulatory agency, in the early 1990's, determined that the reported groundwater impacts as well as localized soil impacts were considered a threat to public health and the environment based on the proposed retail usage of the site. Investigation and monitoring of the soil and groundwater

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proceeded under an enforcement order issued by the agency that contained specific deadlines and milestones for investigation, cleanup and monitoring. Originally, these orders required full investigation of the impacts to soil and groundwater for chemicals released onto the site, and subsequent cleanup to natural background levels of those chemicals. The on-site releases of fuel related chemicals in soil and groundwater were identified as benzene, toluene, ethylbenzene and xylene (i.e., BTEX), as well as total petroleum hydrocarbons. The agency did not, however, require the site to clean the impacts from the chlorinated volatile organic chemicals that were migrating onto the property from up-gradient sources, so long as those chemicals did not impact the shopping center footprint at levels that posed unacceptable health risks to workers and shoppers. The existence of the agency orders, as well as the existence of chemicals in the soil and groundwater from both on-site and off-site activities, reduced the value of the entire 154 acre parcel. Additionally, the project redevelopment costs and the cost and feasibility of full cleanup to these initial "background level" cleanup standards further burdened the property. Development of the shopping center at a cost-effective price at that time was thereby delayed and in doubt.

3 Site closure approach and remedial activities

During the mid-1990's the regulatory agency determined that many redevelopment projects and site cleanups were stalled because of the cleanup standards set at background levels. A reform movement, based on the concept of "working smart, not working hard" was advanced by agency staff and eventually became standard practice for the agency for sites with affected soil and groundwater.

For this site, soil was found to be affected or threatened by releases from the approximate 100 tanks and pits. The agency agreed to allow for the determination of Health Based Cleanup Goals (HBCGs) that were chemical specific and were developed for a proposed commercial (retail) use of the property after redevelopment. The HBCGs were as follows:

- Acetone – 760 milligrams per kilogram (mg/kg)
- Benzene – 0.70 mg/kg
- Ethylbenzene – 900 mg/kg
- Ethylene chloride – 7 mg/kg
- 2-methyl-naphthalene – 120 mg/kg
- Naphthalene – 45 mg/kg
- Toluene – 1600 mg/kg
- Xylenes – 2400 mg/kg

Additionally, the agency agreed that only a representative number of sumps and pits could be investigated, based on the planned redevelopment that would essentially cover the affected soil and eliminate complete pathways from the soil to the planned user. The HBCGs also considered short-term impacts for

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construction workers. What followed was the limited investigation of sumps and pits, with soil excavated and predominantly removed from the site in accordance with standard off-site waste disposal (landfill) characterization, transport and disposal criteria. A Soil Investigation Summary Report and a Soil Remediation Summary Report were prepared following completion of these remedial activities.

For groundwater, the agency determined that for petroleum hydrocarbons, especially those that are gasoline related, natural biochemical processes in soil and groundwater would be capable of completing the cleanup process. As such, cleanup policy for petroleum product cleanup shifted to a risk-based approach. This approach recognized a likely use of the affected groundwater, which in this case was very low, considering that the yield at the shallow depth was low, and that groundwater from the shallow zone (less than 50 feet) was not used in this area due to regional public health considerations. The "low risk" site closure approach for petroleum hydrocarbons as applied to this site includes the following criteria:

- Criteria 1 - The fuel leak has been stopped and ongoing sources, including free product, removed or remediated,
- Criteria 2 - The site has been adequately characterized,
- Criteria 3 - The dissolved hydrocarbon plume is not migrating,
- Criteria 4 - No drinking water wells, deeper drinking water aquifers, surface water, or other sensitive receptors are likely to be impacted,
- Criteria 5 - The site presents no significant risks to human health, and
- Criteria 6 - The site presents no significant risk to the environment.

For Criteria 1, the underground fuel tanks and related fuel lines were removed from the two fueling areas at the site and the soil excavated and treated or removed from the site where the HBCGs and local environmental health agency cleanup objectives (e.g., total petroleum hydrocarbons) were exceeded. Thus a large portion of the source of additional groundwater impacts was eliminated. This approach allowed some residual petroleum product to remain in the soil subject to ongoing future risk management.

For Criteria 2, constituents of concern to groundwater from the fuel releases (i.e., BTEX and TPHg) were investigated and monitored through sampling wells for the 12 year period prior to closure. Adequate site characterization was achieved through the aforementioned testing of the soil at the sumps and pits and this monitoring of the groundwater.

For Criteria 3, concentrations in the perimeter wells (which were on the site) were non-detect and stable and benzene levels within the affected groundwater plume were found to be decreasing from natural biochemical process as confirmed by application of a statistical trend analysis. Additionally, the chemical analyses results from monitoring wells installed to measure the water bearing strata between 25 and 50 feet were non-detect over the twelve year period, illustrating that no vertical migration was occurring.

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For Criteria 4, it was determined that affected groundwater was confined to the site and that no vertical migration was occurring. It was further determined by a search of local county health water well records that no drinking water wells were recorded to exist within 0.25 miles of the site. The closest municipal drinking water well was located some 0.50 miles from the site and was screened in very deep water bearing zones, resulting in no determinable threat from the site's environmental problems. It was further determined that no threat existed to surface waters.

For Criteria 5, no significant risks to human health was determined based on the removal of soil affected above HBCGs from "known" sumps and pits, and a determination that there was a low likelihood of indoor air impacts from potential "unknown" releases from those sumps and pits not specifically investigated. However, risk management measures were determined necessary to assure that any future subsurface activity that intrudes into the subsurface results in a new set of testing, reporting, risk assessment and possible cleanup. Additionally, the residual petroleum hydrocarbons in groundwater underlying the proposed shopping center were evaluated for potential indoor air adverse health affects and were found to be at acceptable levels. However, passive air ventilation was constructed into the shopping center to mitigate any perceived or potential risk.

For Criteria 6, environmental risks were determined to be minimal, in that the entire 154 acre site was to be redeveloped into the shopping center (25%), parking (50%) and new "outer parcel" buildings (25%). As such, no exposure pathways for plants and animals existed.

A Site Closure Report considering the above low risk closure criteria was prepared, submitted and approved by the regulatory agency. However, as part of the closure process, the agency required that a Site Management Plan (SMP) be developed and implemented, and changed as appropriate, so long as residual chemicals or "unknown sources" of chemicals remained in the soil and groundwater. Details of the Site Management Plan (SMP) in general and as required for this site are presented below. However, it should be noted that considerable discussion at the agency occurred surrounding two potential institutional controls, a deed restriction and a regulatory order requiring adherence to the SMP in the future, where new owners and operators and new regulatory personnel might not "remember" the existence and terms of the SMP primarily designed to protect public health.

Deed restrictions are required by some government agencies where residual substances are planned to be managed-in-place at redevelopment sites such at this shopping center. They are used primarily to assure proper disclosure of site conditions (i.e., residual chemicals in soil and groundwater and potential unknown sumps and pits) in property transfers and provide some measure of enforcement capability for the government agency. Deed restrictions sometimes restrict the type of construction allowable for the property, which in this case would have specifically stated that no residential use was acceptable for the site. Also in this case, the deed restriction could have been used to prohibit the use of underlying groundwater for drinking water purposes until such time (if ever) that the groundwater is clean enough (by natural or by groundwater treatment remedial measures) to meet applicable drinking water standards. Deed restrictions are placed by the property owner onto government land ownership records, as part of the deed to the property. They often provide benefits to another party, such as the approving government agency. The existence of these deed restrictions can have a negative impact on property value.

For the shopping center SMP, the approving agency did not require that a regulatory mechanism remain in place after approval of the SMP and site closure. Implementing the SMP became the independent responsibility of the property owner and subsequent property owners. Lessons were learned concerning this decision as described in Case Studies discussed below.

4 Regulatory agency approved site management plan

For this focused risk-based approach to site remediation, where residual substances were planned to remain on the property, a Site Management Plan (SMP) is a useful tool that is developed to help insure that site conditions, and site use and development phase restrictions are organized and communicated. The SMP summarizes the site assessment, risk assessment and risk management plan, and should contain the following elements:

- a summary of site conditions;
- a summary of response measures completed or operating to minimize the mass, concentration or toxicity of residual substances in soil, groundwater and air;
- a summary of ecological and human health risk evaluations;
- a closure plan for temporary engineering control measures; and
- a detailed description of ongoing property management measures including response and reporting plans for future findings in the soil and groundwater.

The site-specific SMP for the shopping center contained the following specific elements:

- Background Information regarding the property, including a description of the property, shall subsurface conditions, site use history, remedial investigations performed for soil and groundwater, and a summary of off-site conditions that are affecting the property (i.e., the chlorinated volatile organic chemicals migrating from nearby sites, but contained in parking lot areas only), and a summary of the current environmental conditions at the property (i.e., residual groundwater hydrocarbon concentrations, specific areas containing residual hydrocarbon in soil),
- Human Health and Ecological Risk Evaluations, including a discussion of the risks posed by the residual chemicals in groundwater and soil ,
- Decommissioning activities necessary to complete closure of monitoring and an experimental air "sparging" system used for

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enhancing "natural" biological processes at work cleaning the groundwater, and

- Property Management measures to be taken during ongoing operations, maintenance and any future redevelopment construction activities. These measures include notification and disclosure requirements, construction safety measures, soil management, and a prohibition of use of groundwater on the property.

5 Case studies evaluating site management plan implementation

It is important to understand that once a SMP is developed and approved, long-term implementation is not assured. For this site, several events have occurred since the SMP was approved, each providing a learning experience related to the usefulness of the SMP as well as the long-term sustainability of the SMP. What follows are descriptions of several of these specific events, each of which are likely at other risk-based corrective action sites. These events include the following:

- Property Transfers,
- Construction of an additional structure or an addition to the existing structure, and
- Re-construction of the building interior.

A property ownership transfer occurred for the shopping center where the SMP played a distinct role in communicating the past history of the site as well as providing a framework for future site management. During the transaction process the approving agency was questioned about implementation of the SMP and whether it had been followed as written. Demonstration of implementation was documented by providing reports to the approving agency for activities completed at the site where the SMP was followed. These instances included where a new major addition was added to the center, involving excavation of the paved parking lot, stockpiling of excavated soil containing some hydrocarbons, and providing for erosion control management of storm water onto waste and imported soil piles. The SMP was utilized to find the locations of known soil impacts to allow for implementation of the proper construction health and safety plans. This information also helped estimate the likely costs of landfill disposal for the excavated soil. Further, since the SMP disclosed the off-site sources of chlorinated volatile organic chemicals on the site, the issues associated with this matter were openly discussed in the marketplace in lieu of potentially having to be resolved through litigation.

In the instance of construction of an underground parking garage, stained and odorous soil was discovered during the course of the excavation activities. The SMP disclosed the potential for paint in the area, and it was subsequently determined that a limited area of paint affected soil and paint related debris was found. Although the SMP required the evaluation of the potential for finding

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"unknown" affected soil at the site, the SMP was silent as to how to manage the finding. In this instance, the SMP was modified and accepted by the approving agency, requiring notification of findings to the agency, the completion of chemical profiling of the "unknown" and the proper excavation and disposal of any hazardous materials found at the event. In this case, the SMP became a "living" document.

The shopping center also had some re-modeling activity that triggered the SMP, including the addition of a loading dock as well as the removal and replacement of some flooring at one of the retail areas. The circumstances surrounding the construction of the loading dock provides a great illustration of the importance of the SMP. The local building authorities were responsible for the building permit associated with this "minor" change to the facility. However, the project construction took place several days before Christmas (during the busiest shopping time of the year) and during the excavation activities a smell of gasoline was discovered late one afternoon. The initial response by the local authorities was to call the fire department. Based on the existence of the SMP, and shopping center staff with knowledge of its existence, it was determined within 24-hours that the gasoline odors came from soil affected by the reported and resolved former gasoline spill where residual petroleum hydrocarbons were allowed to remain in place based on the implementation of a SMP. A potential shopping center closure by the fire department was averted once the facts contained in the SMP were revealed (e.g., the location of the former fuel tanks where the loading dock was being constructed). The lesson learned was that the SMP should have been consulted PRIOR to the start of construction.

For a subsequent event, where an excavation associated with a new floor at a retail area revealed the presence of a "pit filled with something" the SMP was successfully implemented such that the finding of the pit was not a problem, and the substances inside the pit were sampled, removed, and disposed of properly, and the pit filled with sand. In that case, a small delay and a small cost were the only impacts.

6 Summary and conclusions

This case study provided an example of the proper use of risk management measures to protect public health and the environment, following risk assessment and a minimum of cleanup costs for chemicals released to the environment. It is an example of working "smart" to balance the needs and desires of society with the costs of environmental assessment and cleanup to make everyone a "winner". This example of a successful Brownfields project was based on the development and implementation of a Site Management Plan (SMP). In this example, the SMP was implemented after it was written, despite no specific government or other mandate. While this combination of actions can indeed be considered "smart", the issue of sustainability of the SMP through time and future site ownership is an area where more creative thought is required.

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References

[1] Morse, S.I. & Arulanantham, R. The bright and dark sides of environmental risk management, *Strategic Environmental Management*, **1(4)**, 1999.
[2] Arulanantham, R. & Morse, S.I. Brownfields...Everybody's Doing It..., State Bar of California, *Environmental Law News*, **5(2)**, 1996.
[3] Johl, C.J., Feldman, L. & Rafferty, M.T. Put risk-based remediation to work, *Environmental Engineering World*, September-October 1995.
[4] Feldman, L. & Nelson, J. Demonstrating natural attenuation of petroleum hydrocarbons for closure at a redevelopment site, *IPEC*, Albuquerque, New Mexico, October 1998.
[5] www.ci.emeryville.ca.us/bf/brownfields.html
[6] www.terradex.com
[7] www.oaklandpw.com/ulrprogram/pts.pdf

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