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Chapter 3

ACHIEVEMENT OF A BENEFICIAL REUSE DESIGNATION FOR A SPECIALIZED HIGH VOLUME BYPRODUCT

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Abstract: The State of Florida encourages the recycling and reuse of a variety of materials, assuming that it can be accomplished in a manner that protects public health and the environment. A detailed technical and field evaluation was conducted on behalf of and in cooperation with a major municipal utility, to investigate the reuse potential of large volume byproducts from an electrical generating station which employs circulating fluidized bed (CFB) technology for combustion of coal and petcoke as fuel. In cooperation with FDEP, a 18 month field demonstration was conducted to assess stability, leachability, and runoff from one of the CFB byproducts ("EZBase™"). Pads (12 by 50 feet) were constructed of the compacted EZBase™ as well as of materials for which EZBase™ could be substituted (asphalt, limerock, concrete) and were designed to simulate proposed reuse scenarios. Shallow groundwater monitoring wells were installed immediately adjacent to the pads and were monitored monthly for a variety of constituents, in conjunction with surface water runoff samples collected during rainfall events, and soil samples adjacent to all of the pads.. Vanadium emerged as a substance of interest in both surface runoff and in soil, but vanadium was not detected in nearby groundwater wells. The groundwater, soil and storm water runoff data clearly demonstrated that the EZBase™ does not pose hazards to the environment, and demonstrated that the environmental fate of analytes in the byproduct is very similar to the other commonly used products in similar applications. A variety of potential risk-based reuse scenarios were proposed to the state environmental regulatory agency on the basis of human health and ecological considerations, including soil stabilization in environmental remediation applications, road bed and road surface projects, commercial/industrial site paving projects, and road right-of-way application. Toxicological, risk and engineering questions were satisfactorily addressed and approvals were granted for reuse of EZBase™ on a broad scale.

Key words: Beneficial reuse, recycling, circulating fluidized bed, field demonstration

1. INTRODUCTION

In November 1998, JEA, formerly known as the Jacksonville Electric Authority, submitted a permit application to the Florida Department of Environmental Protection (FDEP) for the repowering of two generating units at the Northside Generating Station (NGS). The centerpiece of the proposed repowering project entailed the conversion of two 1960s vintage oil-fired boilers to new, solid fueled state-of-the art circulating fluidized bed (CFB) boilers.

From the inception of the project through design and permitting, JEA expressed its intent to market and sell the byproduct from the CFB units for beneficial reuse. The byproduct from a solid fuel CFB plant is distinct from that of conventionally fired boilers (e.g., pulverized coal, fuel oil, etc.) because it is composed primarily of lime and gypsum, with less than 10 percent by weight being derived as ash from combustion of the fossil fuels. Accordingly, the byproduct from a CFB plant is not considered as an “ash” in the typical sense as the remnant material from conventionally-fired boilers. Over 90 percent of CFB byproduct is a result of the addition of limestone to the boilers to create thermal mass for the fluidized bed and to create the primary scrubbing medium for removal of sulfur gases. The resultant byproduct has excellent material properties that allow it to be used in numerous applications where lime, cement and concrete would otherwise be used.

Preliminary discussions with FDEP indicated that a designation of the byproduct for “beneficial use” was possible and, in fact, would be in alignment with stated Florida policy regarding recycling and reuse at both the State and Federal levels. However, other than for municipal solid waste incinerators (FDEP 2001), implementing procedures for acquiring the beneficial use designation were neither well-defined nor had been routinely received or reviewed by the FDEP since inception of the program. Thus, notwithstanding the clear direction in policy and statute, FDEP staff indicated that there were few examples of approved beneficial use applications to date. One option explored and eventually pursued was to have a relatively small area designed and permitted under the Chapter 62-701 FAC regulations as a solid waste management facility operationally concomitant with the CFBs coming on-line, to allow for storage of the byproduct while it was fully characterized and a market was developed. The decision to seek authorization under a Chapter 62-701 FAC permit (Class I landfill) was primarily based on the limited alternatives available for regulatory coverage of the byproduct storage area (BSA).

Based on the verified demand for uses of the byproduct in Florida and the designed limited capacity of the BSA, JEA approached both the Northeast District and the Solid Waste Offices of the FDEP headquarters in Summer 2003, to discuss how best to pursue expeditious review of and approval for the beneficial use of the JEA CFB byproducts. Numerous meetings were held with various FDEP personnel from both offices to seek input on the most effective method of providing the information needed for FDEP action on the request for beneficial use.

In order to encourage the implementation of recycling/reuse as a desired and desirable public policy, Florida has in place specific statutes. The criteria for judging whether industrial byproducts may obtain exemption from regulation as a solid waste for the purpose of safe and productive use are provided in Florida Statute §403.7045(1)(g), and are summarized as follows:

1. A majority of the industrial byproducts are demonstrated to be sold, used, or reused within 1 year;
2. The industrial byproducts are not discharged, deposited, injected, dumped, spilled, leaked, or placed upon any land or water so that such industrial byproducts, or any constituent thereof, may enter other lands or be emitted into the air or discharged into any waters, including groundwaters, or otherwise enter the environment such that a threat of contamination in excess of applicable Department air or water quality standards and criteria is caused; and,
3. The industrial byproducts are not hazardous wastes.

JEA's operation of the two CFB units at the NGS presently produces two marketable byproducts, both of which are exempt industrial byproducts:

- EZSorb™ is a sorbent byproduct consisting of either unhydrated bed or unhydrated fly ash and sold directly from the silos for a variety of uses where use of quick lime or Portland cement would be appropriate, such as to stabilize and strengthen soils in preparation for other construction activities, and to solidify soils at environmental remediation sites.

- EZBase™ is a sorbent byproduct consisting of hydrated mixed fly and bed ashes. Once removed from the boilers, the dry

> material enters a water hydration system and is sluiced into the BSA (Goodrich and Charhut, 2003), hence the identification as hydrated. The hydrated byproduct has materials properties that make it valuable for the beneficial uses as described in this report.

The byproducts subsequently have been trademarked as EZBase™ (hydrated sorbent mix of fly and bed ashes) and EZSorb™ (unhydrated sorbent byproduct of fly or bed ash).

2. MATERIALS AND METHODS

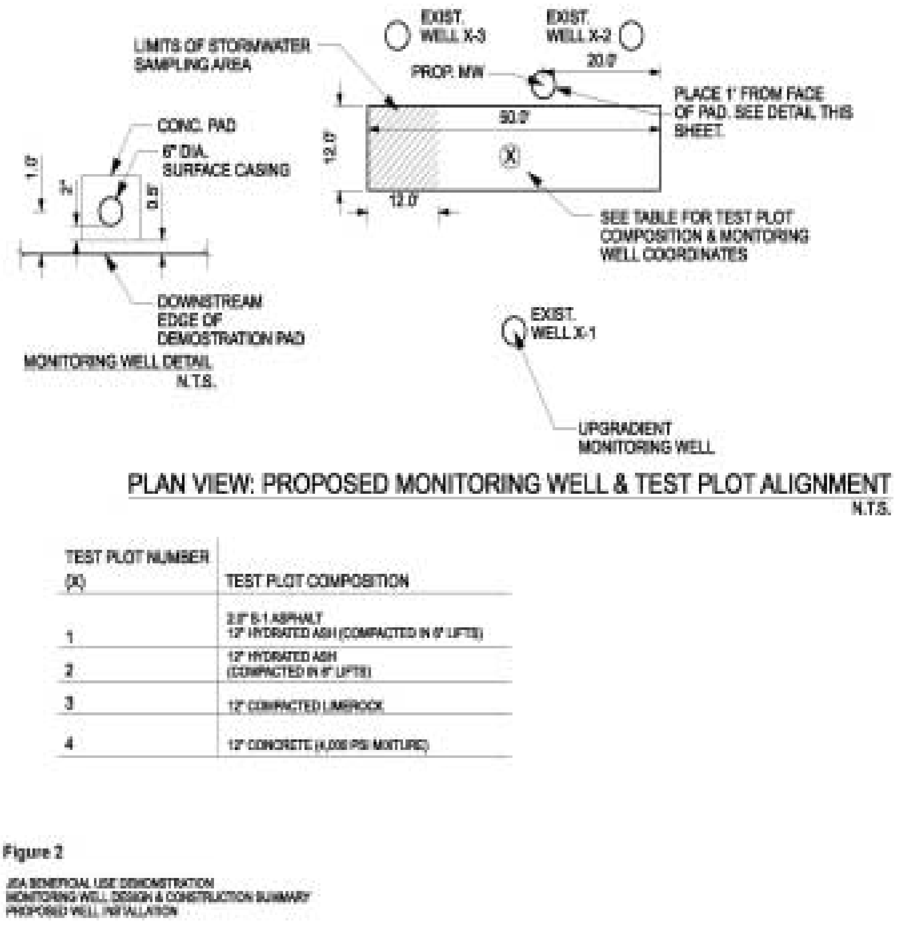
As part of the data gathering process for submittal of the beneficial use designation request to FDEP, a field study was conducted using the EZBase™ product in several applications typical of the market applications for which approval was to be requested. The purpose was to collect soil, groundwater and storm water runoff data for comparison between EZBase™ and similar materials for which EZBase™ would be a suggested replacement.

Test pads were constructed at the JEA Brandy Branch Generating Station located near Baldwin, FL (see Figure 1). The test pads were 12 feet wide by 50 feet long (nominal). The construction details for the test pads are shown in Figure 2 and were arranged as follows:

- Test Pad 1 was composed of 12 inches of compacted EZBase™ that was covered with a surface course of asphalt.
- Test Pad 2 was 12 inches of compacted EZBase™ alone, to compare the EZBase pads with commonly used road construction materials.
- Test Pad 3 was composed of limerock.
- Test Pad 4 was constructed of concrete.


Test Pads
Figure 1
Aerial of Brandy Branch with Test Pad Locations
N

Figure 1.



TEST PLOT NUMBER (X)	TEST PLOT COMPOSITION
1	2.0" S-1 ASPHALT 12" HYDRATED ASH (COMPACTED IN 6" LIFTS)
2	12" HYDRATED ASH (COMPACTED IN 6" LIFTS)
3	12" COMPACTED LIMEROCK
4	12" CONCRETE (4,000 PSI MIXTURE)

Figure 2.

The EZBase™ used for the construction of the pads, as well as the limerock and concrete, were analyzed for metals, semivolatile and volatile organics. The synthetic precipitation leaching procedure (SPLP) also was performed on these samples for the same parametric coverage.

A portion of all test pads (12-ft. x 12-ft. section, approx.) was sloped to one end so that storm water runoff could be collected. Storm water runoff was collected and analyzed after each major storm event using a storm water sampler by Vortox. Storm water was collected after 11 rain events from late April to late June 2004.

Soil surrounding the test pads was sampled at various locations approximately 15 months after installation of the test pads. The surface soil was sampled as well as 0.5 foot below ground surface (ft bgs), 1.0 ft bgs and 2.0 ft bgs. Both upgradient and downgradient soil samples were collected and analyzed for total metals (e.g., aluminum, antimony, arsenic, barium, boron, chromium, iron, lead, manganese, mercury, nickel, selenium, thallium and vanadium.)

Groundwater was monitored by installation of monitoring wells both upgradient ("background") and downgradient from the test pads. As shown in Figure 3, MW X-1 was the upgradient well and was located approximately 10 ft upgradient from each pad. MWX-2 and MW X-3 were approximately 10 feet downgradient from each pad. In addition, a nearer downgradient well was subsequently installed, about 3-4 feet from each pad (e.g., MW X-4; see Figure 3). The groundwater monitoring wells were sampled and analyzed approximately every four weeks for about 18 months for metals, mercury, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), radionuclides (gross alpha, uranium, Radium 226 and Radium 228), hardness, turbidity, pH and sulfates.

3. RESULTS

3.1 Materials of Construction

The chemical analysis of the EZBase™ used to build Test Pads 1 and 2 is shown in Table 1. As shown in Table 1, the maximum concentrations of analytes detected in the EZBase™ were compared with 100% and 50% of the residential, industrial and leachability-based soil guidance values of the Florida Department of Environmental Regulation (FDEP, 2005a), as recommended in the FDEP Reuse Documents. Arsenic, nickel, thallium and vanadium were the chemicals of concern in EZBase™, based on the comparisons with 100% of the values for residential exposure or for leachability.

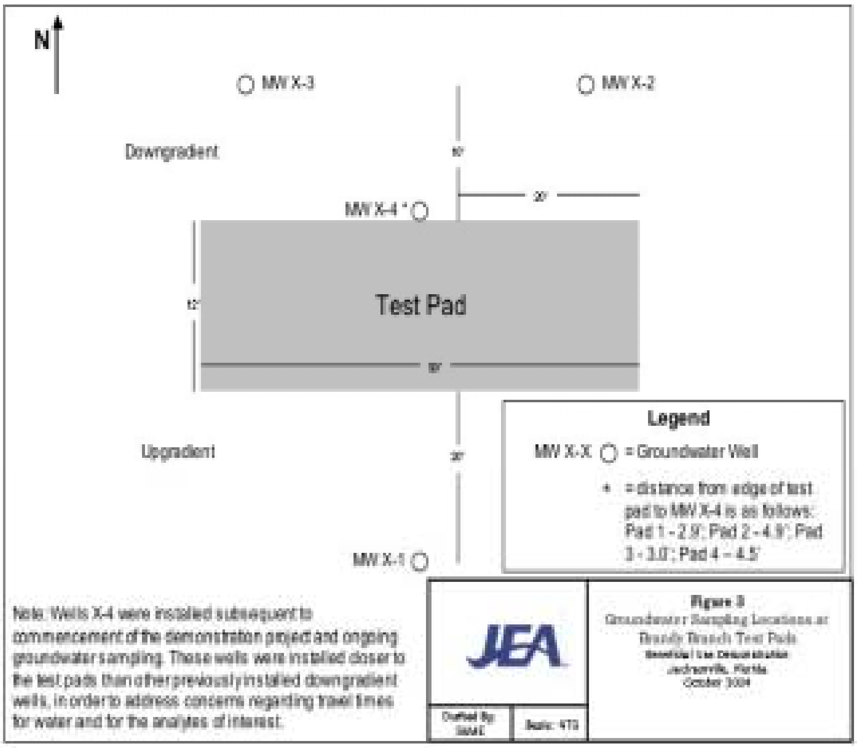


Figure 3.

To assess the potential for leachability, the materials used to construct the test pads also were tested by the Synthetic Precipitation Leachability Procedure (SPLP). The SPLP concentrations were compared with both FDEP groundwater cleanup target levels [(GCTL) (FDEP, 2005a)] or the maximum contaminant level [(MCL)(FDEP, 1995)] and the FDEP Chapter 62-302 concentration for Class III freshwater (FDEP, 1996). As shown in Table 2, lead and Radium 226/228 were the only analytes with a maximum SPLP concentration that exceeded the surface water value. The maximum concentration of sulfates, chloromethane, methylene chloride, antimony, lead, molybdenum, vanadium and Radium 226/228 exceeded either the GCTL or the MCL.

3.2 Storm Water Runoff

The storm water runoff data were compared with the GCTL or MCL for groundwater and the Chapter 62-302 concentration for Class III freshwater. As shown in Table 3, the concentration of aluminum and iron in the storm water runoff exceeded both the groundwater and surface water values for all pads. Lead in the runoff from the EZBase™ pad marginally exceeded the MCL only on May 25, 2004 (e.g., 0.017 mg/L vs the MCL of 0.015 mg/L). The MCL for manganese of 0.05 mg/L also was exceeded in storm water runoff from the asphalt and limerock pads, as well as the rainwater control on two events.

Table 1. Analytical Data and Preliminary Screening Comparisons for EZBase Beneficial Use Demonstration JEA, Jacksonville, Florida, October 2004

	No. Positive/ Total No. of Samples	**95% UCL Conc. (mg/kg)**	**Maximum**	**FDEP RTLs (mg/kg)**					
				100% of Values			**50% of Values**		
				Residential	**Industrial**	**Leachability**	**Residential**	**Industrial**	**Leachability**
EPA METHOD 8260B (volatile organics)									
1,1-Dichloroethene	2/20	NC	0.02	95	510	0.06	47.5	255	0.03
EPA METHOD 8270C SIM (semi-volatile organics)									
Naphthalene	1/20	NC	0.018	55	300	1.3	27.5	150	0.65
Anions									
Chloride	15/15	NC	910	NF	NF	NF	NF	NF	NF
Sulfate	15/15	NC	37,000	NF	NF	NF	NF	NF	NF
Nitrate-N	0/10	NC	BDL	14,000	NA	SPLP	7,000	NA	SPLP
EPA METHOD 6010 (inorganics)									
Aluminum	23/23	17,504	23,800	80,000	NA	SPLP	40,000	NA	SPLP
Antimony	0/12	NC	BDL	27	370	5.4	13.5	185	2.7
Arsenic	22/22	5.4	8	2.1	12	29	**1.05**	**6**	14.5
Barium	21/22	74	96	120	130,000	1,600	**60**	65,000	800
Boron	22/22	112	154	7,900	200,000	SPLP	3,950	100,000	SPLP
Chromium	22/22	17	19	210	470	38	105	235	19
Iron	22/22	14,949	22,200	53,000	NA	SPLP	26,500	NA	SPLP
Lead	22/22	9.2	18	400	1,400	SPLP	200	700	SPLP
Manganese	21/21	61	72	3,500	43,000	SPLP	1,750	21,500	SPLP
Mercury	22/22	0.19	0.29	3	17	2.1	1.5	8.5	1.05

Nickel	22/22	515	710	**340****	35,000	**130**	**170**	17,500	**65**
Selenium	4/22	3.0	3.7	440	11,000	5.2	220	5,500	**2.6**
Sodium	20/21	928	1,100	NF	NF	NF	NF	NF	NF
Thallium	1/12	NC	9.1	**6.1**	150	**2.8**	**3.05**	75	**1.4**
Vanadium	22/22	2,814	4,100	**67****	10,000	**1,100**	**33.5**	5,000	**550**

Bold indicates that the maximum concentration exceeds the SCTL
** Direct exposure based on acute exposure considerations
SPLP (Synthetic Precipitation Leaching Procedure) SPLP test for leachability recommended
NA Not Applicable for this pathway at any concentration
NC Not calculated because an insufficient number of samples or positive results are available
☐ Preliminary Substances of Interest

RTL Reuse Target Levels (FDEP, 2001; FDEP, 2002; FDEP, 2003; FDEP, 2004; FDEP, 2005a)

Table 2. Comparison of Regulatory Values with SPLP Data for EZ Base Beneficial Use Demonstration JEA/Jacksonville, FL, October, 2004

Parameter	**95% UCL Concentration (µg/L)**	**Maximum Concentration (µg/L)**	**No. Positive/ Total No. of Samples**	**FDEP GCTL or MCL (µg/L)**	**Chapter 62-302 Class III, fresh (µg/L)**
SPLP, EPA METHOD 300					
Chloride	NC	20,000	1/1	250,000	NF
Sulfate [b]	NC	1,200,000	1/1	250,000	NF
Nitrates	NC	100	1/1	10,000	NF
SPLP, EPA METHOD 8260B					
Acetone	NC	560 Y	1/5	630	1,700
Chloromethane[b]	NC	3.3	1/11	2.9	NA
Methylene chloride [b]	NC	6.6	5/11	5	≤1,580
Toluene	NC	2.4	1/11	40*	NA
SPLP, EPA METHOD 6010					
Antimony [b]	NC	100	1/10	6	4,300
Barium	215	240	20/20	2,000	NA
Boron	NC	59	1/1	630	NF
Chromium	17	17	7/20	100	207
Lead [a,b]	NC	20	5/20	15	3.2
Molybdenum [b]	310	310	10/15	35	NA
Potassium	NC	24,000	10/10	NF	NF
Sodium	23,919	24,000	10/10	160,000	NA
Vanadium [b]	92	150	20/20	49	NA
Radionuclides					
Radium 226 (pCi/L) [a,b]	NC	4.24	5/10	5 (226+228) pCi/L	5 (226+228) pCi/L
Radium 228 (pCi/L) [a,b]	1.48	1.48	9/10	5 (226+228) pCi/L	5 (226+228) pCi/L
Uranium (µg/L)	NC	0.721	4/10	0.021	NA

FDEP GCTL- Florida Department of Environmental Protection Groundwater Cleanup Target Level, Table I, Chapter 62-777, Florida Administrative Code

SPLP- Synthetic Precipitation Leaching Procedure

Y The laboratory analysis was from an improperly preserved sample

* Secondary standard, based on taste and odor considerations

Shading indicates Preliminary Substances of Interest

NA Not Available

NC Not calculated because an insufficient number of samples or positive results is available.

Values for Lead were calculated based on a default hardness of 100 mg/L as $CaCO_3$.

[a] Selected based on comparison with surface water criteria.

[b] Selected based on comparison with groundwater criteria.

Table 3. Comparison of Storm Water Runoff Between Pads Beneficial Use Demonstration JEA/Jacksonville, Florida, October 2004

Analyte	Pad[1]	Statistic				CTL (mg/L) [2]	
		n/N [3]	Minimum [4]	Maximum [4]	Mean [4,5]	GW	SW
Aluminum	Asphalt	12/12	0.38	11	3.04	0.2	0.013
	EZBase	12/12	1.5	10	4.28		
	Limerock	10/11	<0.2	12	3.45		
	Concrete	11/11	0.04	9.6	3.47		
Antimony	Asphalt	0/4	<0.02	<0.02	--	0.006	4.3
	EZBase	0/4	<0.02	<0.02	--		
	Limerock	0/4	<0.02	<0.02	--		
	Concrete	0/4	<0.02	<0.02	--		
Arsenic	Asphalt	0/12	<0.008	<0.01	--	0.050	0.05
	EZBase	0/12	<0.008	<0.01	--		
	Limerock	0/11	<0.008	<0.01	--		
	Concrete	0/11	<0.008	<0.01	--		
Barium	Asphalt	5/12	<0.01	0.038	0.017	2	NP [6]
	EZBase	6/12	<0.01	0.023	0.014		
	Limerock	5/11	<0.01	0.033	0.015		
	Concrete	5/11	<0.01	0.022	0.012		
Boron	Asphalt	0/12	<0.05	<0.05	--	0.63	NP
	EZBase	0/12	<0.05	<0.05	--		
	Limerock	0/11	<0.05	<0.05	--		
	Concrete	0/11	<0.05	<0.05	--		
Chromium	Asphalt	1/12	<0.01	0.018	0.011	0.1	0.27
	EZBase	8/12	<0.01	0.034	0.014		
	Limerock	3/11	<0.01	0.032	0.014		
	Concrete	3/11	<0.01	0.025	0.014		
Iron	Asphalt	12/12	0.11	2.6	0.74	0.3	1.0
	EZBase	12/12	0.015	3.0	0.90		
	Limerock	11/11	0.12	3.3	1.24		
	Concrete	11/11	0.12	2.2	0.81		
Lead	Asphalt	4/12	<0.005	0.011	0.006	0.015	0.018
	EZBase	3/12	<0.005	0.017	0.006		
	Limerock	2/11	<0.005	0.007	0.005		
	Concrete	1/11	<0.005	0.0095	0.005		
Manganese	Asphalt	6/12	<0.01	0.100	0.028	0.050	NP
	EZBase	3/12	<0.01	0.027	0.014		
	Limerock	8/11	<0.01	0.055	0.024		
	Concrete	3/11	<0.01	0.027	0.012		
Mercury	Asphalt	0/12	<0.0002	<0.0002	--	0.002	0.000012
	EZBase	0/12	<0.0002	<0.0002	--		
	Limerock	0/11	<0.0002	<0.0002	--		
	Concrete	0/11	<0.0002	<0.0002	--		
Nickel	Asphalt	0/12	<0.02	<0.04	--	0.1	0.17
	EZBase	2/12	<0.02	0.056	0.036		

		Statistic				CTL (mg/L)[2]	
	Limerock	0/11	<0.02	<0.04	--		
	Concrete	0/11	<0.02	<0.04	--		
Selenium	Asphalt	0/12	<0.01	<0.01	--	0.05	0.005
	EZBase	0/12	<0.01	<0.01	--		
	Limerock	0/11	<0.01	<0.01	--		
	Concrete	0/11	<0.01	<0.01	--		
Sodium	Asphalt	2/12	<1.0	3.1	1.2	160	NP
	EZBase	12/12	11	180	62		
	Limerock	2/11	<1.0	2.1	1.2		
	Concrete	11/11	2.8	13	7.4		
Thallium	Asphalt	0/4	<0.01	<0.01	--	0.002	0.0063
	EZBase	0/4	<0.01	<0.01	--		
	Limerock	0/4	<0.01	<0.01	--		
	Concrete	0/4	<0.01	<0.01	--		
Vanadium	Asphalt	12/12	0.011	0.11	0.041	0.049	NP
	EZBase	12/12	0.097	0.31	0.160		
	Limerock	8/11	<0.01	0.034	0.016		
	Concrete	10/11	<0.01	0.073	0.020		
pH	Asphalt	11/11	4.63	9.65	7.49[7]	6.5-8.5	
	EZBase	11/11	5.54	9.67	8.54[7]		
	Limerock	10/10	7.77	8.76	8.53[7]		
	Concrete	10/10	6.65	10.4	8.31[7]		

1. Asphalt over EZBase (Pad 1); EZBase (Pad 2); Limerock (Pad 3); Concrete (Pad 4)
2. Cleanup Target Level (CTL) for groundwater (GW) and surface water (SW) per Chapter 62-777, F.A.C.
3. n/N = number of detections/number of samples
4. reported in mg/L, except pH reported in standard units (su)
5. If analyte detected at least once, then reporting limits used as discrete value in the calculation when less than value reported for other observations.
6. NP=not promulgated
7. median, not mean value reported
8. NC= not calculated

The storm water runoff from the EZBase pad also exceeded the MCL for sodium on one occasion. The GCTL of vanadium of 0.049 mg/L also was exceeded by the storm water runoff from the EZBase pad on most events and also by the runoff from the concrete pad after the rainfall event of 6/20/04. The pH of the storm water runoff from all four pads exceeded the groundwater and surface water regulatory values after most rainfall events.

3.3 Soil

None of the soil samples that were taken from areas near the test pads had concentrations of metals that exceeded either the residential or industrial soil cleanup target levels (SCTLs) established by FDEP (FDEP, 2005a).

There was one surface soil sample that was collected at the edge of the EZBase™ pad that had a vanadium concentration of 55 mg/kg, less than the SCTL of 67 mg/kg. Therefore, it appeared that vanadium that might be found in runoff from the EZBase™ pad was sequestered in the soil immediately adjacent to the pad. The transport of low concentrations of vanadium from the surface of the EZBase™ pad, followed by retention in the surficial-to-shallow portion of the soil column, conformed to observations made recently by Martin and Kaplan (1998). These authors hypothesized that the presence of aluminum and iron oxides and small amounts of clay minerals and organic matter were responsible for retention of the metals in the top 7.5 cm of soil.

The soil samples also were tested by SPLP. Essentially, the SPLP for all of the upgradient and downgradient samples exceeded the MCL for iron and aluminum. In addition, there were many of the samples, both upgradient and downgradient, that exceeded the MCL for lead (0.015 mg/L) and the GCTL for vanadium (0.049 mg/L). Neither lead nor vanadium was detected in any of the groundwater samples that were collected from either the upgradient or downgradient wells from any of the pads. Therefore, it did not appear that these SPLP results were a reflection of the effect of the pad materials on the surrounding soils.

3.4 Groundwater

Groundwater was tested for metals (including mercury), semivolatile organic compounds, volatile organic compounds, polycyclic aromatic hydrocarbons (PAHs), radionuclides, pH, sulfate, nitrate and chloride. The only analytes in groundwater that routinely exceeded MCLs were aluminum, iron, manganese and pH (see Table 4). Many of the upgradient and downgradient wells at all pads exceeded the MCL of 0.2 mg/L for manganese. All wells at all the pads exceeded the secondary MCL of 0.3 mg/L for iron. Many of the downgradient wells at all pads, with the exception of the downgradient wells of the concrete pad, exceeded the MCL of 0.05 mg/L for manganese. The pH of most of the wells exceeded the secondary standard of 6.5su to 8.5su.

There also were sporadic exceedances of the MCL for dibromochloromethane, bromodichloromethane, bromoform, benzene and PAHs in some of the wells during the process. However, the sporadic exceedances of these chemicals did not appear to be related to the test pads. Vanadium was not detected in any of the groundwater wells greater than the detection limit.

3.5 Risk Assessment

As part of the Beneficial Use Demonstration and Exemption Determination, potential human exposure scenarios and associated risk from contact with soil that may be impacted by the end-uses proposed were evaluated. Potential exposure to the uncompacted EZBase™ product itself also was evaluated.

For direct exposure to soil, the maximum reported concentrations in the top two feet (i.e., surface soils) were compared with the FDEP default residential and industrial soil SCTLs (FDEP, 2005a). None of the detected chemicals from any of the test pads exceeded either the default residential or commercial/industrial direct exposure SCTLs. This suggested that exposure to the soil immediately adjacent to the pads (or planned EZBase™ applications) presents an insignificant risk to humans even under an unrestricted 350 day per year residential scenario.

Based on the comparison of the results for the uncompacted EZBase™ with the commercial/industrial SCTLs, there are no constitutents of concern (COCs) for direct exposure. Potential direct exposure receptors based on a commercial/industrial scenario would be an indoor/outdoor maintenance worker, a JEA employee, a construction worker or an infrequent visitor/trespasser. However, since there were no COCs based on comparison with the commercial/industrial SCTLs, there would be no exposure of concern for these receptors. Although there are some COCs for consideration regarding leachability, the groundwater results at the site indicate that leachability also is not of concern for EZBase™ as it will be beneficially reused. The qualitative evaluation for exposure to soil is summarized in Table 5. The exposure assessment matrix for uncompacted EZBase™ is shown in Table 6.

Table 4. Comparison of Groundwater Data Between Pads

Analyte	MCL	Pad	Wells	n/N	Concentration Detected (mg/L)		
					Minimum	Maximum	Mean
Aluminum	0.2 mg/L	Asphalt	Upgradient	12/18 (12)	0.23	1.1	0.68
			Downgradient	26/34 (26)	0.21	5.2	0.79
		EZBase	Upgradient	7/17 (7)	0.25	7.4	2.8
			Downgradient	32/34 (32)	0.21	1.7	0.7
		Limerock	Upgradient	4/18 (3)	0.26	0.69	0.43
			Downgradient	24/35 (24)	0.21	3.1	0.73
		Concrete	Upgradient	14/17 (14)	0.24	4.5	1.06
			Downgradient	24/34 (24)	0.25	1.1	0.57
Iron	0.3 mg/L	Asphalt	Upgradient	19/19 (19)	2.5	7.8	3.8
			Downgradient	35/35 (35)	1.7	19	8.3
		EZBase	Upgradient	18/18 (18)	1.9	5.2	3.2
			Downgradient	37/37 (36)	0.08	39	13
		Limerock	Upgradient	18/18 (18)	1.6	3.7	2.2
			Downgradient	34/34 (33)	0.08	11	6.0
		Concrete	Upgradient	18/18 (18)	2.0	8.4	5.0
			Downgradient	35/35 (35)	1.8	16	6.9
Manganese	0.05 mg/L	Asphalt	Upgradient	11/11 (7)	0.034	0.15	0.07
			Downgradient	27/27 (27)	0.06	0.27	0.12
		EZBase	Upgradient	10/10 (10)	0.084	0.17	0.12
			Downgradient	27/27 (24)	0.041	0.22	0.09
		Limerock	Upgradient	10/10 (6)	0.02	0.11	0.06
			Downgradient	27/27 (16)	0.03	0.23	0.09
		Concrete	Upgradient	10/10 (10)	0.06	0.19	0.10

					Concentration Detected (mg/L)		
			Downgradient	27/27 (1)	0.02	0.11	0.04
pH	6.5-8.5 su	Asphalt	Upgradient	19/19 (17)	4.8	6.8	5.7
			Downgradient	35/35 (29)	5.2	7.21	5.9
		EZBase	Upgradient	18/18 (18)	5.2	6.1	5.4
			Downgradient	37/37 (33)	4.9	7.1	5.7
		Limerock	Upgradient	18/18 (14)	5.0	6.9	5.6
			Downgradient	34/34 (24)	5	7.2	5.8
		Concrete	Upgradient	18/18 (16)	5.8	7.4	6.1
			Downgradient	35/35 (29)	5.1	7.1	5.6

n/N = Number of detections/number of samples (Exceedances)
MCL= Maximum Contaminate Level, FDEP, 1995.

Table 5. Exposure Assessment Matrix for Soil Beneficial Use Demonstration JEA/ Jacksonville, Florida October 2004

Potential Receptor	**Exposure Pathway for Soil**				
	Commercial Parking Lot	**Road Bed**	**Soil Stabilization (Remedia- tion)**	**Residential Driveway**	**Covered Road**
Child Resident (0 to 6 yrs)	**NA**	**NA**	**NA**	4	2
Aggregate Resident (0 to 30 yrs)	**NA**	**NA**	**NA**	2	1
Commercial/Industrial (maintenance worker)	3	1	3	1	1
JEA Employee	1*	1*	1*	**NA**	**NA**
Transportation Personnel	1	1	1	**NA**	**NA**
Construction Worker	4*	4*	5*	3*	4*
Infrequent Visitor/ Trespasser	2	1	1	2	1

NA	Not Applicable. The exposure potential for the noted receptor/pathway combinations are not expected to be significant compared with the other combinations for those receptors.
Level 1	Minimal exposure potential with minimal exposure magnitude.
Level 2	Minimal exposure potential with moderate exposure magnitude.
Level 3	Moderate exposure potential with moderate exposure magnitude.
Level 4	High exposure potential with moderate exposure magnitude.
Level 5	High exposure potential with high exposure magnitude.
*	OSHA Regulations apply.

Table 6. Exposure Assessment Matrix for Uncompacted EZBase Beneficial Use Demonstration JEA/Jacksonville, Florida October 2004

Potential Receptor	**Exposure Pathway for Uncompacted EZBase**		
	Commercial Parking Lot	**Road Bed**	**Soil Stabilization (Remediation)**
JEA Employee	1*	1*	1*
Transportation Personnel	1	1	1
Construction Worker	4*	4*	5*
Infrequent Visitor/Trespasser	2	1	1

Level 1	Minimal exposure potential with minimal exposure magnitude.
Level 2	Minimal exposure potential with moderate exposure magnitude.
Level 3	Moderate exposure potential with moderate exposure magnitude.
Level 4	High exposure potential with moderate exposure magnitude.
Level 5	High exposure potential with high exposure magnitude.

* OSHA Regulations apply.

4. DISSCUSION

Based on the results of the demonstration project that have been outlined in this report, the FDEP issued a Beneficial Use Determination and designated the material as an industrial byproduct rather than a solid waste. In a letter to JEA dated July 25, 2005 (FDEP, 2005b), the FDEP indicated that the industrial byproduct could be used in the following applications:

1. Final top surface for roads, parking lots, lay down yards and similar industrial and commercial applications using compacted EZBase™ either alone or with stone (such as granite or limestone) or asphalt millings rolled into the top surface;
2. Compacted as a base course for civil applications in accordance with Florida Department of Transportation (FDOT) Standard Specification Section 200, where the EZBase™ will be covered with a friction surface (final top surface) such as asphalt or concrete or compacted EZBase™;
3. Stabilized base course (meeting compaction requirements) for civil applications in accordance with FDOT Standard Specification Sections 160 and 230, where a final top surface such as asphalt or concrete or compacted EZBase™ will be used;
4. Mixed with existing limestone base for civil applications in compliance with FDOT Standard Specification Section 210, where a final top surface such as asphalt or concrete or compacted EZBase™ will be used; and,
5. Used in stabilization processes for remedial projects where access controls (engineering and/or institutional) are in place and where the remedial project has been reviewed and approved by the Department.

5. CONCLUSION

JEA designed, installed and subsequently monitored a Beneficial Use Demonstration (BUD) project. FDEP staff at all levels offered strong encouragement to proceed with this field demonstration and provided valuable input on how best to capture appropriate data to accurately assess potential environmental impacts from the byproduct itself relative to other commodity construction products that the byproduct would displace. JEA has determined that both the legal/regulatory background of recycling/reuse policy and the marketing and the environmental data acquired during the BUD project support the conclusion that the sale of the byproducts from the

JEA Northside CFB project, as defined herein, for use in the demonstrated markets is protective of human health and the environment, especially when measured against the environmental impacts posed by the noted replacement materials currently-utilized for the associated construction applications.

REFERENCES

FDEP (Florida Department of Environmental Protection). 1995. Chapter 62-550. Drinking water standards, monitoring and reporting. February 7, 1995.

FDEP (Florida Department of Environmental Protection). 1996. Chapter 62-302. Surface Water Quality Standards. December 26, 1996.

FDEP (Florida Department of Environmental Protection). 2001. Guidance for preparing municipal waste-to-energy ash beneficial use demonstrations. Final. Revision No. 1. February 27, 2001.

FDEP (Florida Department of Environmental Protection). 2002. Chapter 62-777, F.A.C. Workshop Draft 3. March 27, 2002.

FDEP (Florida Department of Environmental Protection). 2003. Chapter 62-777, F.A.C. August 2003 ERC Draft. June 6, 2003.

FDEP (Florida Department of Environmental Protection). 2004. Soil Cleanup Target Levels. Table 2. Chapter 62-777, F.A.C. Draft. July 12, 2004.

FDEP (Florida Department of Environmental Protection). 2005a. Chapter 62-777. Contaminant Cleanup Target Levels. April 17, 2005.

FDEP (Florida Department of Environmental Protection). 2005b. Letter from Ms. Mary Jean Yon, Director, Division of Waste Management, to Ms. Susan Hughes, JEA. July 25, 2005.

Goodrich, W.G. and D.E. Charhut. 2003. High concentrated slurry system for fluidized bed boiler ash disposal. United Conveyor Corporation. Waukegan, Illinois.

Martin, H.W. and D.I. Kaplan. 1998. Temporal changes in cadmium, thallium, and vanadium mobility in soil and phytoavailability under field conditions. Water, Air, Soil Pollut. 101:399-410.