SECTION 2

BLUE RIVER GROUNDWATER FLOW SYSTEM

2.0 BLUE RIVER GROUNDWATER FLOW SYSTEM

2.1 Description of Area

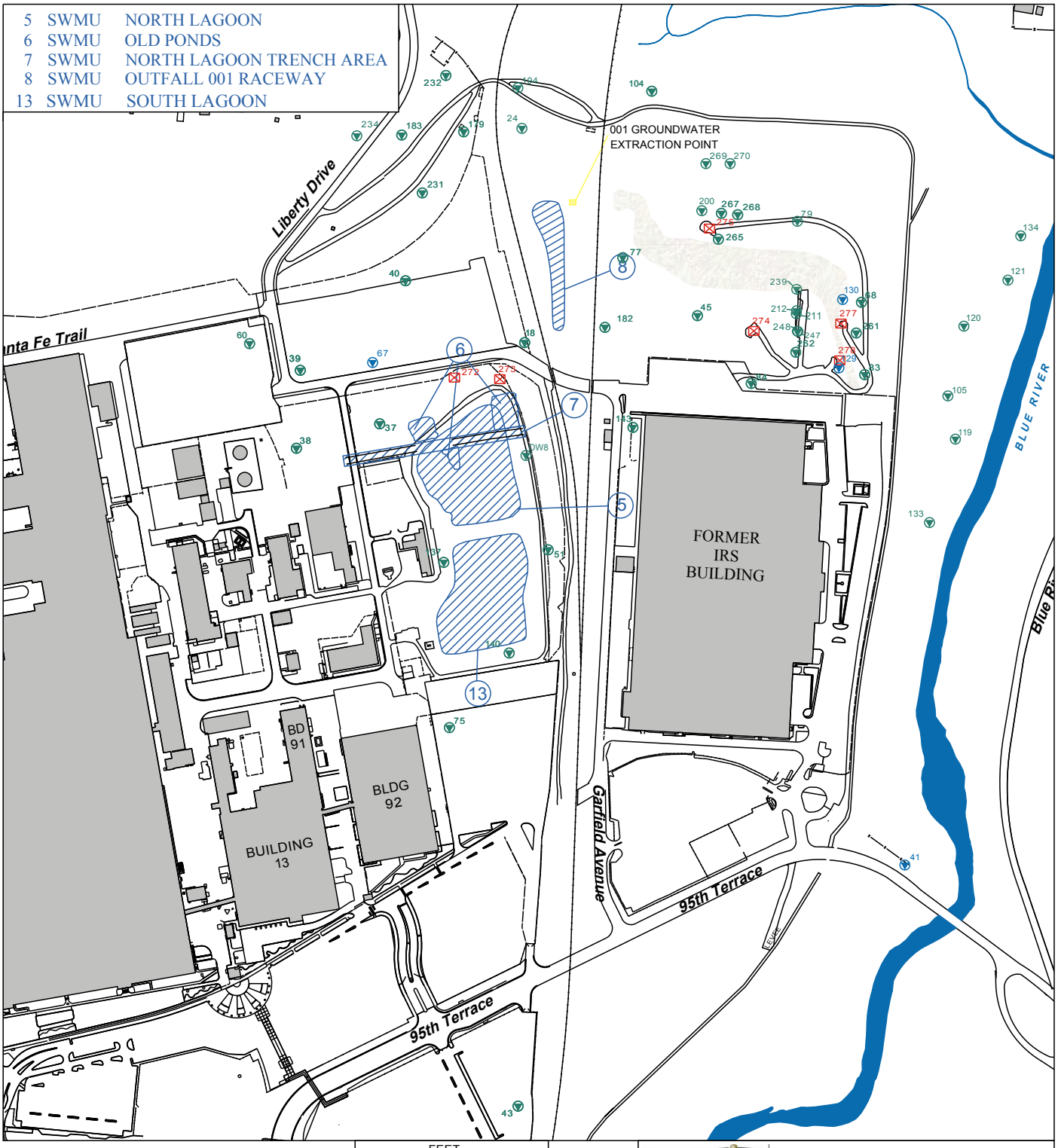
The Blue River Groundwater Flow System (BRGFS) is defined as that area of the Bannister Federal Complex where groundwater not captured by the groundwater pumping system or the Outfall 001 groundwater seep collection system ultimately discharges to the Blue River (Figure 2.1). The BRGFS includes SWMUs No. 5 (North Lagoon), No. 6 (Old Ponds), No. 7 (North Lagoon Trench Area), No. 8 (Outfall 001 Raceway), and No. 13 (South Lagoon) as well as the Former Landfill. The flow system includes property belonging to the Union Pacific Railroad, DOE and the General Services Administration (GSA). It also encompasses open-land formerly occupied by the Blue River. In times past, the river channel included a meander that looped to the west, in the area north of the former IRS Building (Figure 2.2). The former drainage way of the Blue River is now grass-covered and undeveloped and serves as a part of a storm water retention basin. Trees are sparsely situated throughout.

A portion of the NPDES regulated storm sewer known as the Outfall 001 Raceway runs north/south through the flow system as an open drainage between two Union Pacific railroad tracks directly east of the GSA parking lot (Figure 2.2). The 001 storm sewer drains the north-central and northeast portions of the KCP. Historical sampling of the 001 Outfall stormwater compliance point, the Outfall 001 raceway and a railroad headwall in the area noted the presence of solvent contamination. Further investigation revealed that this contamination was believed to be coming from groundwater seepage. In order to help eliminate this source of contamination to the 001 surface water system, a subdrain system isolated from surface flow was constructed to capture groundwater seepage emanating from a hillside immediately west of the raceway. Groundwater seepage from the area of the west railroad headwall and the 001 raceway was routed in 1993 to a newly constructed lift station where the captured groundwater is pumped to the groundwater treatment facility for treatment. This system is referred to as the 001 groundwater seep collection system. The location of the collection sump for this system is shown in Figure 2.1 shown as the “001 Groundwater Extraction Point”.

In addition, the BRGFS also includes 6 pumping wells, 272, 273, 274, 275, 277 and 278 (Figure 2.1).

2.2. Alluvial Stratigraphy

Stratigraphy in the BRGFS is complicated where portions of the alluvium have been removed by erosion adjacent to the Blue River valley. Also complicating the hydrostratigraphy in this area are historical construction activities associated with the U. S. Army Corps of Engineers flood-control program, the construction of the former IRS/NARA building as well as activities related to the use of the Former Landfill. As a result, large quantities of fill material comprise the unconsolidated sediments in areas of the flood retention basin north of the IRS/NARA building. In addition, significant quantities of fill were added in the early years of the KCP in areas northeast of the DOE MMB. The IRS/NARA building is built on fill material. The nature of this material is unknown.



In-service monitoring well location
In-service water level only
In-service interceptor well location

Cattails

FEET
0 125 250 500
0 25 50 100 150
METERS

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Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.1: Blue River Flow System
Date:	02/14/2012

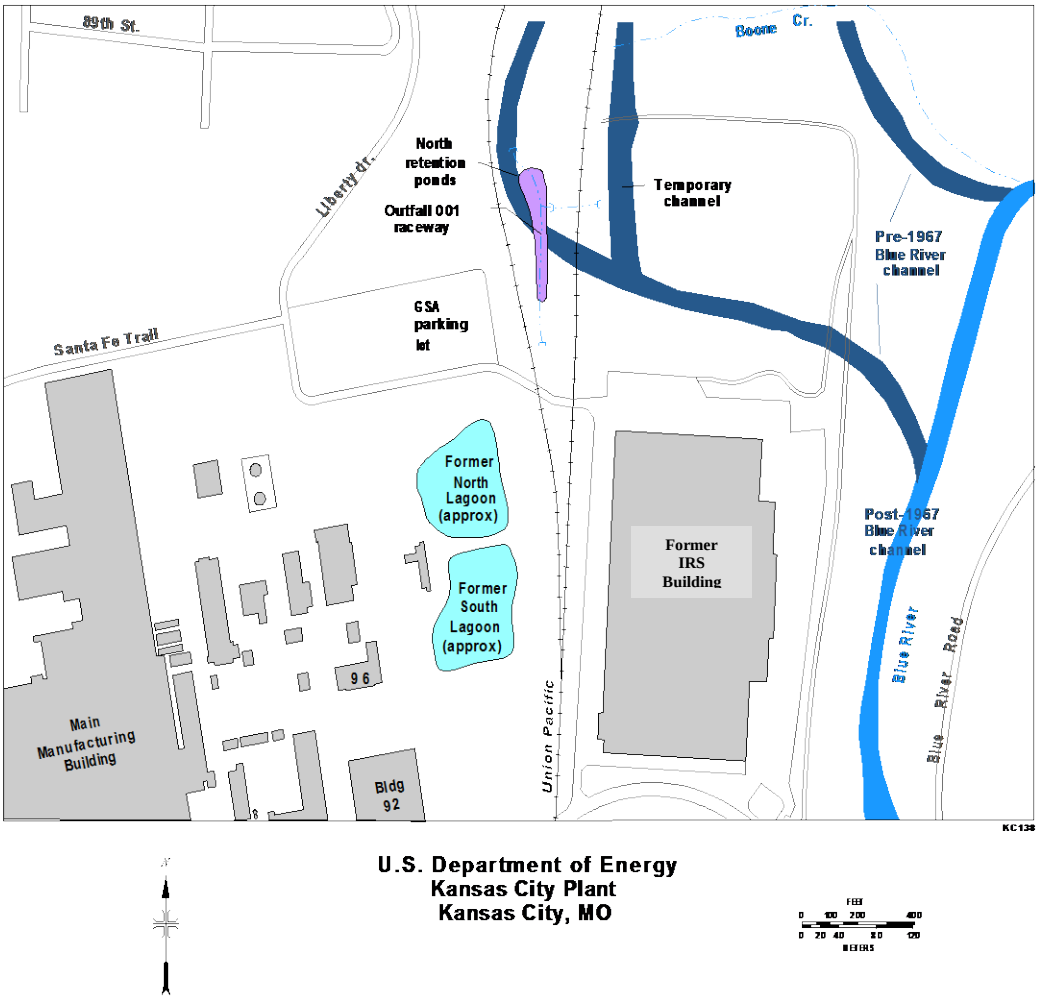

Figure 2.2: Area of Former Blue River channel in the Northeast Area

2.3 Monitoring Wells

DOE owned wells located in the BRGFS are single, dual, or triple completion wells. That is up to three, isolated, individual, 2 inch PVC well screens are placed in the same borehole. Other wells owned by the USACE are single completion wells. The well completion configurations were based partially on the location of the well installation. In the western portion of the flow system, near the former south lagoon, there is approximately 30 ft. of saturated material, compared with only 15 to 20 ft. in the eastern portion near the Blue River. Consequently, wells in the eastern portion are generally single or dual completion wells. Triple completion wells in this flow system include wells 18, 37, 38, 39, and 40. The single completion wells are screened in the basal gravel. The dual completion wells are screened across the water table and in the basal gravel. The triple completion wells have the same screened intervals as dual completion wells above with the addition of a middle screen generally completed at approximately 20 ft. below ground surface. During early phases of site investigation, a sand zone was encountered at certain locations. It is this zone that the middle completions were targeting. Subsequent sampling and hydraulic testing indicated that there was nothing unique about this middle zone. Consequently, only single and dual completion wells are now installed.

Eighty three monitoring wells comprised of one hundred twenty five completions (lower (L), middle (M) and upper (U)) are used to determine the type, nature, and extent of groundwater contamination in the BRGFS (Figure 2.1). Lithologic descriptions and completion diagrams for the DOE owned wells shown in Figure 2.1 are provided in the *Compendium of Lithologic Logs and Completion Diagrams for Monitoring Wells at the U.S. Department of Energy Kansas City Plant* (Kayenta, 2002).

2.4 Work Performed in 2011

The KCP completed active corrective action in 2006. The site is currently operating under what DOE terms "Long Term Stewardship" whereby the site implements final remedies derived from the RCRA corrective action program.

A class 3 permit modification request was sent to MDNR and EPA in 2011 that requested an expansion of the area covered under corrective action to include the entire BFC. GSA was requested to be added as a Permittee. In addition, a modification of the BRGFS groundwater pumping regime was requested based on results of groundwater modeling performed in 2010 (Laase, 2010b). Expanding the description of Facility to cover the entire BFC incorporates the Former Landfill as discussed earlier. The landfill is being addressed by the USACE under the Formerly Utilized Defense Sites (FUDS) program managed under the EPA CERCLA program. Additional investigations by the USACE are planned for 2012 in the Former Landfill area. The GSA will also be conducting investigations in the area of the former IRS/NARA building.

Three GSA wells installed several years ago exist around the perimeter of the IRS/NARA building. These wells were surveyed for subsurface integrity and redeveloped in 2011 by DOE. All three wells were installed by Geoprobe and were screened ~ 20’ bgs thereby rendering these wells the equivalent of upper completion wells and are shown in the upper completion Plate in Appendix A. Companion lower completion wells will be installed by hollow stem auger, developed and surveyed by GSA in 2012.

As a result of an informal agreement with the USACE, water levels from all USACE owned wells surrounding the Former Landfill were sampled as a part of DOE's second semi-annual sampling event. These water levels were used in preparation of potentiometric surface maps in this report. These USACE landfill wells will be sampled for water quality in the 2012 second semi-annual sampling event.

Water levels from the three GSA wells surrounding the IRS/NARA building were not sampled by DOE in 2011.

2.5 Groundwater Flow Directions

Potentiometric surface maps based on 2011 water level data collected as a part of the second semi-annual sampling event are provided as Figures 2.3 and 2.4 with actual water levels provided in Table 2.1 at the end of this section. Water levels from all BRGFS wells were collected over a short period of time as a separate step in the sampling process (i.e., separately from the actual sampling event). Static water levels collected over a large area over a short time interval reduces water level variability providing a more accurate representation of groundwater flow. The second semi-annual field sampling often takes a month to complete.

An area of water retention corresponding roughly to the former Blue River channel is shown in the far northeast corner of BRGFS figures. This area, informally called the "Cattails", can be seen as a lightly shaded area in between wells 45 and 265 (Fig. 2.3). Fieldwork studies determined that recharge from this drainage area causes groundwater mounding which deflects the BRGFS contaminant plume to the east soon after entering the lower Northeast Area (DOE 2000). Organic rich environments such as exist in the cattail area are also conducive to contaminant degradation by biological means.

2.5.1 BRGFS Upper Completion Water Levels

A groundwater mound is again manifested by elevated water levels in wells 75, 137, 76 (ICGFS), 140 and 51 near the former North and South Lagoons. This mounding may be due to stormwater recharge into large drainage ditches that surround the area immediately south and east of the former lagoons. It may also be due to an abundance of buried utilities that ran from the MMB to the former lagoon area. The fill around these utilities likely retains water. The mound dissipates at its north end just south of pumping wells 272 and 273. Flow on the east side of the mound runs eastward toward the Blue River while flow north of the mound flows toward and into pumping wells 272 and 273 or travels northeastwardly toward the area of pumping wells 277, 278 and 274. Flow on the west side of the divide at the former lagoon area is westward toward the Indian Creek Flow System while flow south of the divide is toward the southeast to the Blue River.

FEET
0 125 250 500
0 25 50 100 150
METERS

- In-service monitoring well location
- In-service water level only
- In-service USACE owned well
- In-service interceptor well location

Contour Interval: 2ft.

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Drawing Name:	Figure 2.3: Blue River Flow System Upper Completion Potentiometric Surface Map, Fall 2011
Date:	01/31/2012

Cattails

FEET
0 125 250 500
0 25 50 100 150
METERS

In-service monitoring well location

In-service water level only

In-service USACE owned well

In-service interceptor well location

Contour Interval: 2ft.

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Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.4: Blue River Flow System Lower Completion Potentiometric Surface Map, Fall 2011
Date:	01/31/2012

Flow in the northern portion of the BRGFS is predominantly eastward. The effect of groundwater pumping is noted from water levels collected from monitoring wells located near pumping well 275 just north of the cattail area. A slight modification to the eastwardly flow is noted in the area of pumping wells 277 and 278 though complete capture is not evident.

Elevated water levels were again noted in monitoring wells 41U and 43U located in the southeast portion of the flow system. These wells were utilized in preparation of upper completion maps in 2011. Historically, water levels from these wells were not utilized due to the anomalously high water levels they exhibited. However, repeated assessment of subsurface integrity through video analysis noted no reason to discount water levels from these wells. The reason(s) for the elevated water levels in these wells is unknown. No buried utilities exist in the area of well 43 that would cause this feature. The presence of continuous bubbling up through the very top of the well screen was noted in well 41. The nature and source of this phenomenon is unknown.

Limited water level information exists in the area of the former IRS/NARA Building. Nevertheless, potentiometric surface elevations are shown to provide a best estimate of groundwater flow in this area of the Bannister Federal Complex, that is, eastward flow toward the Blue River. Additional data points to be installed in this area in 2012 by USACE and GSA will provide a better representation of flow in this portion of the BFC.

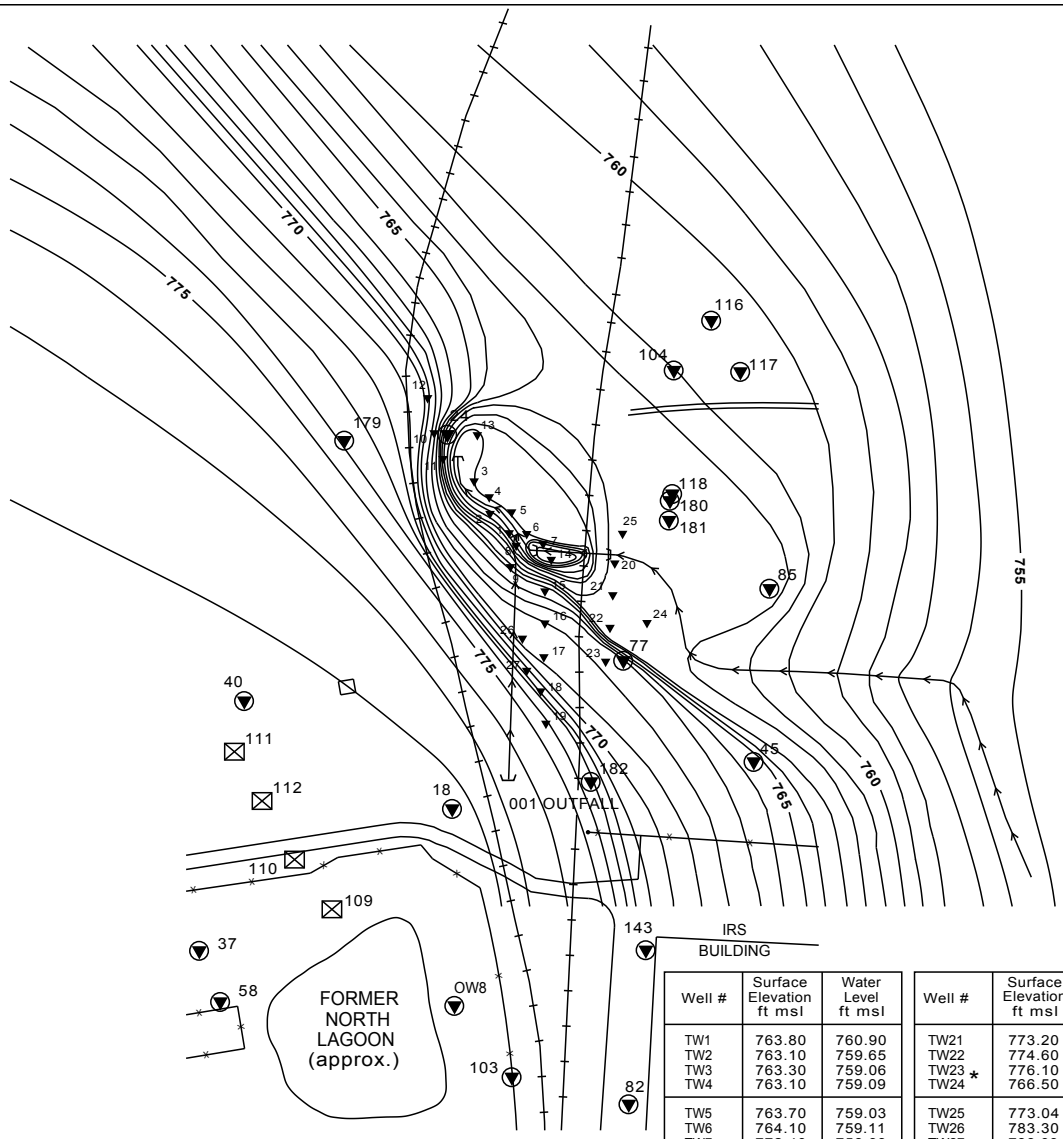
With the exception of distorted flow caused by the elevated water level in well 41, flow in the area of the Former Landfill was predominantly east-southeast.

2.5.2 BRGFS Lower Completion Water Levels

Flow in lower completion wells from the 2011 second semi-annual sampling denoted the following features: A groundwater mound with a long axis running roughly from monitoring well 51 near the former south lagoon south and westward through well 140 to well 209 in the ICGFS was noted (Figure 2.4). Flow from the northern half of this divide is northeastward, toward pumping wells 272, 273, 274, 277 and 278 or east-northeastward toward the Blue River. Flow from the southern half of this divide is toward the Blue River with a minor component flowing southwestwardly toward the Building 91 sump in the ICGFS.

The marked groundwater depression noted in 2010 in the area of pumping well 275 north of the cattails was absent in 2011 due to dry conditions lowering the local water table below the pump intake in this well during the time of sampling. A groundwater depression is again noted in the area of surrounding pumping wells 277 and 278. The location of these depressions creates an apparent groundwater mound in the area of monitoring well 179 in the northeast corner of the flow system.

A perturbation in flow is not manifested surrounding pumping well 274 from water levels collected. This is due to the absence of monitoring wells immediately surrounding this well.



Well #	Surface Elevation ft msl	Water Level ft msl
TW1	763.80	760.90
TW2	763.10	759.65
TW3	763.30	759.06
TW4	763.10	759.09
TW5	763.70	759.03
TW6	764.10	759.11
TW7	772.40	758.93
TW8	764.40	760.65
TW9	764.40	764.40
TW10	771.90	767.90
TW11	765.70	764.60
TW12	772.20	769.92
TW13	774.80	758.96
TW14	775.40	755.15
TW15	775.80	765.46
TW16	780.70	768.25
TW17	786.59	768.78
TW18	791.60	771.71
TW19	792.60	774.53
TW20	769.50	761.37

Well #	Surface Elevation ft msl	Water Level ft msl
TW21	773.20	762.33
TW22	774.60	762.49
TW23 *	776.10	767.59
TW24	766.50	753.74
TW25	773.04	762.17
TW26	783.30	768.13
TW27	788.09	772.15
KC18-L	795.60	778.67
KC24	772.40	761.87
KC45-L	773.90	765.77
KC85	780.60	762.89
KC77	775.29	767.42
KC104-L	786.07	760.90
KC116	773.56	760.16
KC117	785.26	760.58
KC118	773.70	762.46

* Data not used for contouring
msl = mean sea level
TW = Temporary Well

EXPLANATION

- In-Service Monitoring Well Location
- In-Service Interceptor Well Location
- Drainage Ditch With Flow Direction
- Headgate
- Temporary Well Location
- Potentiometric Contour (Contour Interval: 1 ft)

FEET 0 50 100 200
0 10 20 40 60 METERS

N. GRID NORTH

KC814
REV 7/21/95

Potentiometric surface of 001 Outfall area based on water levels from temporary wells and nearby permanent monitoring wells.

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Project Name: 2011 Annual Groundwater Corrective Action Report

Drawing Name: Figure 2.5: Potentiometric surface of 001 Outfall area

Date: 01/17/2012

A change in flow direction is again produced near well 24 in the far northern end of the flow system. This feature, present in previous years, is believed to be due to the fact that groundwater discharges to the 001 drainage way, a fact noted in the Northeast Area RFI (DOE, 1993a) (see also Figure 2.5). A portion of this discharge is captured by the 001 groundwater seep collection system.

Groundwater flow in the area of the Former Landfill undulates producing southerly and/or southeastwardly flow in the area of wells KC06-01, 15, 16, KC95-01 and 42 to an overall eastward direction of flow noted from water levels collected in wells KC95-04, 41 and KC06-02.

Vertical Flow

Vertical flow in the BRGFS can be evaluated by comparing water levels collected from upper and lower completions within same well. A downward vertical component of flow is noted from most wells in the BRGFS. Diagrams of measured water levels for wells in this flow path are provided at the end of this section. They include wells 37, 18, 182 and 45. As can be seen by evaluation of these figures, a consistent downward component of flow is noted with the elevation of groundwater in upper completions greater than that of lower completions. While a downward component of flow is noted in most wells, there are exceptions. Monitor well 60 in the northeast DOE parking lot and well 232 at the northern edge of the flow system are two exceptions. These two wells exhibit an upward gradient.

2.6 Groundwater Flow Rates

The horizontal hydraulic gradient in the BRGFS varies significantly due to topography. While most of the facility has gentle sloping topography, over 30 ft. of elevation change occurs from the western side to the eastern side of this flow system. This change in surface elevation influences the potentiometric surfaces, and corresponding groundwater velocities as shown below.

In the northern portion of the flow system near wells 234L, 232L and 24L, a groundwater velocity of approximately 773 feet/year was calculated flowing east southeastwardly. A hydraulic conductivity of 3 ft/day as calculated from a pump test in this area in 1993 (DOE 1993a) was used along with a porosity of 10%. The gradient was calculated at 0.0709 ft/ft.

In the area north of the former IRS Building near wells 18L, 77L and 45L the 2011 second semi-annual sampling event horizontal hydraulic gradient is 0.03416 ft/ft. Using a porosity of 10% and a hydraulic conductivity of 34.0 ft/day as calculated from a pump test in the gravel layer for this area (Woodward Clyde, 1997) a groundwater flow rate of approximately 4237 ft/yr. was calculated. Flow direction was to the northeast.

The effect of groundwater pumping is noted in the eastern portion of the flow system when utilizing wells 83L, 119L and 121L located east of pumping wells 277 and 278 near the Blue River. Groundwater capture is noted with a northwesterly (upgradient) flow. The 2011 horizontal hydraulic gradient here is calculated at 0.000425 ft/ft. Using a hydraulic conductivity

of 126 ft/d from a slug test from well 243 (DOE, 2000) and an effective porosity of 10%, a groundwater velocity of approximately 195 ft/yr. is calculated flowing upgradient to the west.

Flow in the area east northeast of the Former Landfill near wells KC06-02, KC95-04 and 41 produced a calculated flow velocity of 751 ft/yr with an eastwardly flow direction. A hydraulic conductivity of 1.5 ft/day derived from bail tests of wells in the area (BFEC, 1986) was used along with a porosity of 10%. A gradient of 0.1373 ft/ft was calculated .

Contaminant Transport
Dissolved organic contaminants at the KCP are subject to both physical (adsorption/absorption) and biological attenuation processes. The extent to which these mechanisms have occurred and are occurring is dependent on the size and age of the spills and the biogeochemical conditions in the aquifer. Over the sixty years since the initial solvent release, a balance has been established between the rate of migration from the source areas and attenuation/removal processes.

2.7 Groundwater Contamination

This section discusses contaminant concentration levels in groundwater in the BRGFS from sampling conducted in the fall of 2011. A brief description of source areas is also provided. In addition, contaminant trend graphs are provided at the end of this section to assist the reader in evaluating long term contaminant trends in individual wells.

2.7.1 Source Areas

The primary source areas contributing to groundwater contamination in the BRGFS are releases from the Old Ponds (SWMU 6) and the North Lagoon Trench Area (SWMU 7) (Fig 2.1). The nature of the historical releases from these sites has been discussed in previous annual reports (DOE 1995, 1996).

Minor contamination is also found in the northern portion of the flow system in the area of well 179. Contamination in well 179 was investigated in the Outfall 001/Northeast Area RFI (DOE, 1993a). The contamination in this well was found to be localized and may have been related to overflows from the North Lagoon that flowed into a ditch that fed into this area. Overall contamination has been decreasing slowly over time in this well. It is important to note that the former underground Tank Farm and former North and South Lagoons are not considered significant contaminant source areas. All were closed under RCRA requirements in the late 1980's with closure consisting of material removal to a predetermined depth or concentration.

The area known as the Old Ponds and North Lagoon Trench area (SWMUs 6 and 7) actually comprise the contaminant source in this area. It is important to note that these SWMUs are present on a land surface that predates that of the lagoons. This is manifested by soil borings showing fill residing in the upper 12-15 feet in this area and the fact that contamination from the Old Ponds resides at a depth of 10-15 feet below current ground surface.

2.7.2 Contaminant Distribution and Extent

Over twenty five years of sampling groundwater in the BRGFS has demonstrated that there are three organic compounds of primary concern in groundwater: Trichloroethylene (TCE) and its anaerobic degradation products 1,2 dichloroethylene (1,2-DCE), and vinyl chloride. In general, if contamination is detected within the BRGFS, the concentrations of the primary contaminants will be the highest present. Thus, the horizontal and vertical extent of other contaminants will, in general, be equal to or less than the horizontal and vertical extent of the primary contaminants. Figures 2.6 through 2.11 display the vertical and horizontal extent of each of the primary organic contaminants in the upper and lower BRGFS well completions for the 2011second semi-annual sampling event. Figures 2.12 through 2.14 show the extent of 1,1 dichloroethene (1,1-DCE) and 1,1 dichloroethane (1,1-DCA) in the BRGFS. These compounds are the fourth and fifth most common groundwater contaminants at the KCP.

The zero-concentration boundary in contaminant figures is inferred and is somewhat arbitrary. Routinely, placement of the zero-concentration boundary is approximately half-way between a contaminated well and the closest well where no contamination was detected. In some cases, it is necessary to estimate plume extent using wells that contain only low or sporadic contamination. Historical site knowledge by the author is also utilized in preparation of contaminant figures.

Each compound specific contaminant figure shows by color the presence and extent of contamination at levels both above and below a given compound's site specific clean up level. That is, the reader can see the extent of the groundwater contaminant plume that exceeds site clean-up standards by the color shading of the plume.

Also of note is that all DOE owned BRGFS wells including water level only wells were sampled for the presence of contamination in the 2011 second semi-annual sampling event.

The figures also show potentiometric surfaces to augment understanding of contaminant movement. A discussion of each figure is provided. A comprehensive table showing all detections of compounds in BRGFS wells as a part of the 2011 first and second semi-annual sampling events is provided at the end of this section as Table 2.2. Hard copy data from the 2011-second semi-annual sampling event is provided in Volume 2 of this report.

Contaminant trend graphs for selected BRGFS wells are provided at the end of this section.

Compliance point wells for this flow system are pumping wells 277 and 278.

2.7.2.1 TCE, Upper Completion Wells

TCE was again present in a band running from well 37 to well 182 (Fig. 2.6). The source of TCE is derived from the Old Ponds (SWMU 6). The TCE concentration at its most upgradient point (well 37) detected TCE at 10.3 µg/L during the second semi-annual event, considerably less than the 8,000 to 11,000 µg/L levels detected during the late 1980's. This decrease is most likely a result of the degradation of TCE in the subsurface environment. As can be seen in the contaminant trend graph for well 37 at the end of this section, the concentration of TCE

degradation products 1,2-DCE and vinyl chloride has remained roughly the same over the same time period while TCE has declined significantly. TCE was also detected in well 182U at 58.1 µg/L. These were again the only two upper completion detections of TCE in the entire flow system. This is believed to be related to the overall age of the TCE plume, the time allowed for degradation and the fact that a predominant downward vertical gradient exists promoting migration of contamination into lower completion wells.

2.7.2.2 TCE, Lower Completion Wells

TCE lower completion contamination in the Northeast Area was confined to the two source area pumping wells 272 and 273 and monitoring wells 37 and 67 associated with the Old Ponds (SWMU 6). Of interest are locations where TCE is not now detected. Specifically, groundwater monitoring wells 182 and 45 which represent the next most downgradient wells in this area were void of contamination. Well 45 has not detected TCE since 2005, while well 182 has sporadically detected low levels of TCE over the last several years. This absence suggests significant degradation of this source contaminant over the years (see contaminant trend graph provided at the end of this section). It may also be related to the action of pumping wells 272 and 273 and their ability to contain migration from contaminant source areas. TCE was present in well 37 at 15.1 µg/L and 67 at 5.4 µg/L. Pumping wells 272 and 273 detected TCE at 808 and 83.3 µg/L, respectively.

2.7.2.3 1,2-DCE, Upper Completion Wells

An area of contamination at and just downgradient of well 37 again defines the primary source of 1,2-DCE upper completion contamination corresponding to the area of the Old Ponds detected 1,2-DCE at 30,400 µg/L (Fig. 2-8). 1,2-DCE was also detected in wells 67, 182 and 45 at 5.6, 6.4 and 271 µg/L, respectively. A minor amount of 1,2-DCE contamination was noted in well 77 at 1.5 µg/L which continues to sporadically detect the compound. The 1,2-DCE plume extends to pumping well 274 where the majority of mass is captured. A smaller component of the plume is again present in a well immediately upgradient of the permeable reactive barrier (iron wall) as noted by 1,2-DCE in well 211 at 1.6 µg/L. A decreasing 1,2-DCE trend is noted in this well. 1,2-DCE contamination was not detected in the upper completion of well 261 downgradient of the permeable reactive barrier in 2011 as was the case in 2010.

Well 39U located in the northwest portion of the flow system did not detect 1,2-DCE for the second straight sampling event. This well had consistently detected the compound at several hundred ppb in the 1980's but since 1994 has shown a consistent decrease in contamination. Since 2008 1,2-DCE has been non-detect. It is believed that the reduction of contamination in this well is due to a combination of downward hydraulic gradient, a flushing of the source area over time (the area is not believed to contain DNAPL), and in-situ biodegradation. Contaminant trend graphs for this and other wells are provided at the end of this section.

A small, low level, localized area of 1,2-DCE upper completion contamination was also found in well 51 near the former south lagoon at 1.2 µg/L well below the site clean-up standard of 70 µg/L.

2.7.2.4 1,2-DCE, Lower Completion Wells

The Old Ponds define the primary area of 1,2-DCE lower completion contamination expressed by wells 37, 67 18 and 182 along with results from pumping wells 272 and 273. Well 67 is a designated water level only well but was sampled for contamination in the 2011 second semi-annual sampling event.

1,2-DCE lower completion contamination in these Old Pond source area wells ranged from 1050 µg/L in well 182 to 14,900 µg/L in pumping well 272. Contamination migrates northeastward from this area until it reaches the location of the former Blue River channel now defined by the cattail area. This drainage area acts as a hydraulic barrier inhibiting northward migration of the plume. An elevated rate of biodegradation is also believed to occur as discussed in the revision to the KCP site conceptual model (Laase, 2010). The perimeter of the source area portion of the plume is bounded by well 39 on the westward upgradient fringe, OW8 to the south and wells 40 and 77 to the north.

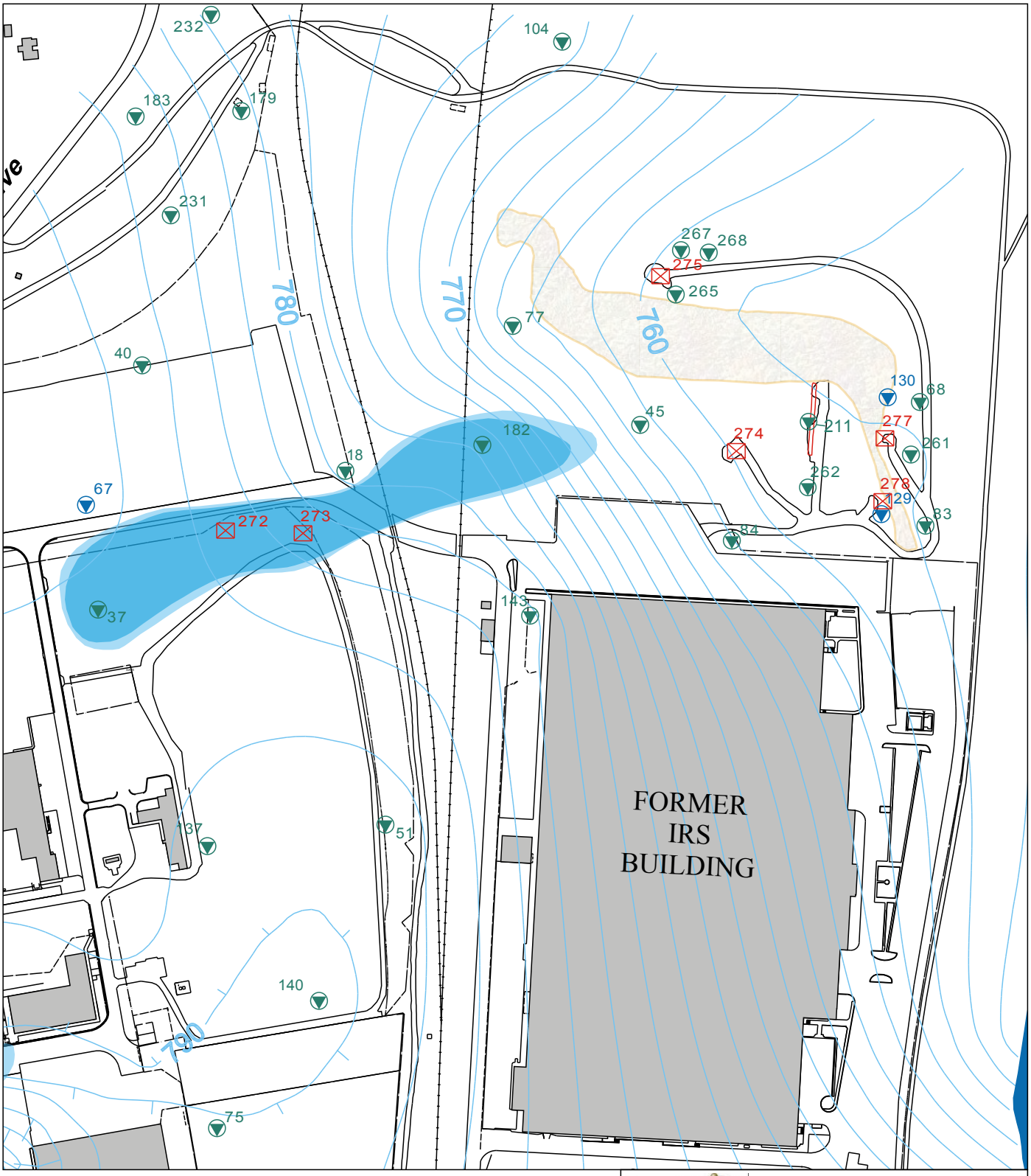
While limited contamination has been detected on the north side of the cattail area, the lateral (east-west) extent of this contamination is limited based on sampling conducted in nine piezometers installed in an east-west trend at 50 foot intervals just north of the cattails as a part of the Lower Northeast Area investigation (DOE, 2000). Repeated sampling of these piezometers noted that only the piezometer located at what is now well 265 detected contamination. In 2011, well 265 detected 1,2-DCE at 29.3 µg/L while the adjacent pumping well installed to halt flow northward to Boone Creek (well 275) detected the compound at 242 µg/L. Wells 200 and 267 just downgradient of this pumping well detected 1,2-DCE at 1.1 and 0.85 µg/L, respectively.

Overall 1,2-DCE contamination in the BRGFS runs eastward toward pumping well 274. 1,2-DCE was detected in pumping well 278 on the east side of the permeable reactive barrier in the second semi-annual sampling event at 242 µg/L while well 277 detected only 0.53 µg/L.

A small area of contamination was noted in the far north portion of the flow system evidenced by contamination in well 179 at 25.9 µg/L.

A localized area of 1,2-DCE contamination at 1.7 µg/L was again noted in well 137 near the west side of the former South Lagoon.

The low level presence of 1,2-DCE in wells 119, 105, 120 and 121 along the Blue River is not unusual but the detection in four wells at the same time is unusual and has occurred in the last two sampling events (2010, 2011). Review of data from monitoring wells near pumping wells 277 and 278 indicate a complete absence of 1,2-DCE contamination. Wells 262, 68, 83, and 261 were all non-detect for 1,2-DCE (Fig. 2.9). In an attempt to understand the cause of these detections additional wells previously approved for abandonment but retained for possible future use were sampled in early 2012. These results, shown in Table 4.10, show the absence



TCE Concentrations

- mdl to 5 µg/L
- 5 to 100 µg/L

FEET 0 50 100 200
0 25 50 METERS

- In-service monitoring well location
- In-service water level only
- In-service USACE owned well
- In-service interceptor well location

Contour Interval: 2ft.

Cattails

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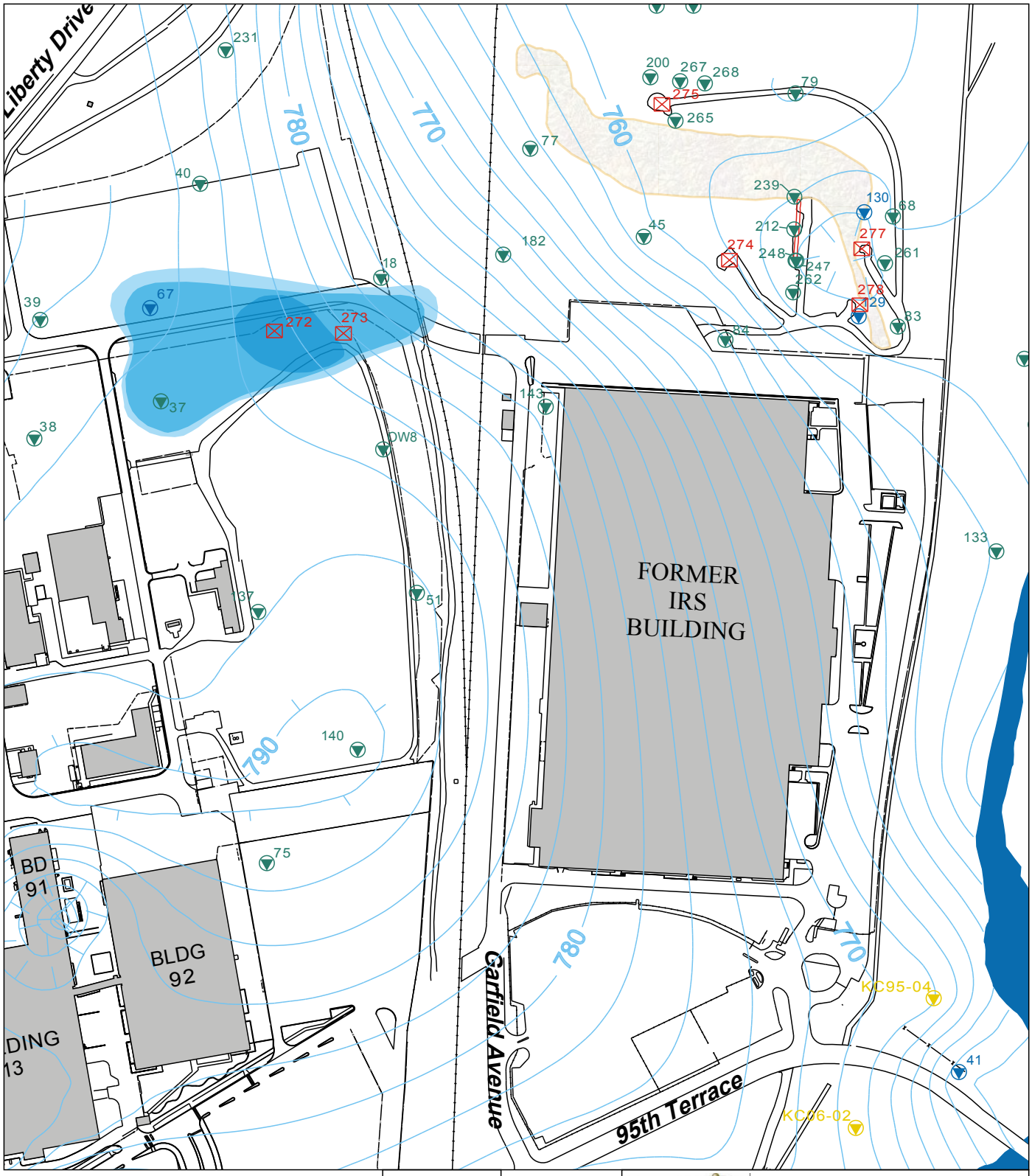
Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.6: Blue River Flow System Upper Completion TCE Contamination, Fall 2011
Date:	01/31/2012



TCE Concentrations

- mdl to 5 µg/L
- 5 to 100 µg/L
- 100 to 1,000 µg/L

FEET 0 50 100 200 / METERS 0 25 50

- In-service monitoring well location
- In-service water level only
- In-service USACE owned well
- In-service interceptor well location

Contour Interval: 2ft.

Cattails

Kansas City Plant
National Security Asset

NNSA National Nuclear Security Administration

The Kansas City Plant is operated and managed by Honeywell Federal Manufactureing & Technologies, LLC, for the NNSA.

Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.7: Blue River Flow System Lower Completion TCE Contamination, Fall 2011
Date:	01/31/2012

1,2-DCE Concentrations

- mdl to 70 µg/L
- 70 to 100 µg/L
- 100 to 1,000 µg/L
- 1,000 to 10,000 µg/L
- 10,000 to 100,000 µg/L

- In-service monitoring well location
- In-service water level only
- In-service USACE owned well
- In-service interceptor well location

Contour Interval: 2ft.

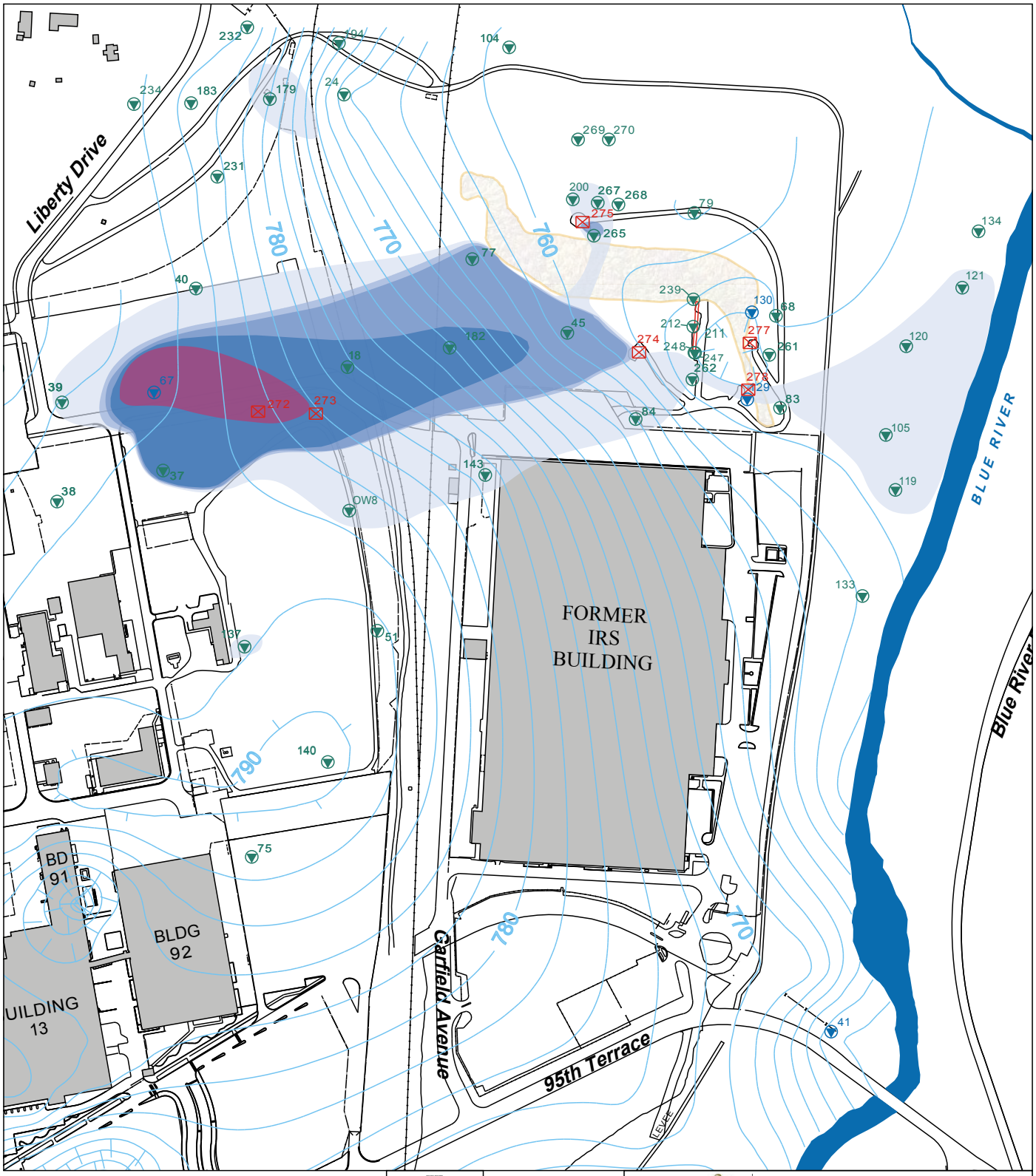
Cattails

Kansas City Plant
National Security Asset

National Nuclear Security Administration

The Kansas City Plant is operated and managed by Honeywell Federal Manufactureing & Technologies, LLC, for the NNSA.

Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.8: Blue River Flow System Upper Completion 1,2-DCE Contamination, Fall 2011
Date:	02/03/2012



1,2-DCE Concentrations

- mdl to 70 µg/L
- 70 to 100 µg/L
- 100 to 1,000 µg/L
- 1,000 to 10,000 µg/L
- 10,000 to 100,000 µg/L

FEET 0 50 100 200
0 25 50 METERS

N

- In-service monitoring well location
- In-service water level only
- In-service USACE owned well
- In-service interceptor well location

Contour Interval: 2ft.

Cattails

Kansas City Plant
National Security Asset

NNSA National Nuclear Security Administration

The Kansas City Plant is operated and managed by Honeywell Federal Manufactureing & Technologies, LLC, for the NNSA.

Project Name:	2011 Annual Groundwater Corrective Action Report
Drawing Name:	Figure 2.9: Blue River Flow System Lower Completion 1,2-DCE Contamination, Fall 2011
Date:	02/08/2012

of 1,2-DCE contamination. Historical narrative by the author in previous annual reports suggested matrix diffusion as a possible cause of the sporadic detections of contamination in these wells.

Furthermore, over the last two sampling events groundwater flow in this area has been westward back toward pumping wells 277 and 278. While an upward trend is not apparent, 1,2-DCE in these wells will be watched closely. Finally the pump in pumping well 278 was lowered 2 feet in January 2012 to allow longer operation before running out of water. This well did not pump in the months of January and October due to an absence of water and operated only sparingly during February and September for the same reason.

The BRGFS 1,2-DCE lower completion main plume was bounded on the south by well OW8, the west by well 39 and north by wells 40, 77, 200 and 267 exhibiting contamination at 7.9, 46.4, 1.8, 307, 1.1 and 0.85 µg/L, respectively (Fig. 2.9). Well 39 located at the western edge of the north IRS parking lot has exhibited a downward trend in 1,2-DCE contamination over time while contaminant trends in wells 40 and OW-8 have remained, overall, steady.

2.7.2.5 Vinyl chloride, Upper Completion Wells

Well 37, located in the area of the Old Ponds has historically defined the main area of vinyl chloride contamination in BRGFS upper completion wells. This was again true in 2011 with the well exhibiting vinyl chloride contamination at 2480 µg/L.

The vinyl chloride plume runs east-northeast through the area of pumping wells 272 and 273. As in previous years, no vinyl chloride was detected in surrounding upper completion wells 18, 182 or 45. A small localized area of vinyl chloride contamination was detected in well 77U in 2010 was absent in 2011.

2.7.2.6 Vinyl chloride, Lower Completion Wells

Vinyl chloride lower completion contamination was present in the area of the Old Ponds with the highest levels again present in monitoring well 18 at 1200 µg/L and pumping wells 272 and 273 at 1170 and 2490 µg/L, respectively (Fig. 2.11). The plume extends northeastward to well 77 and eastward to pumping well 274. Northward movement is inhibited by the action of the cattail area giving rise to an unorthodox plume shape. This contamination follows along the southern edge of the cattails except for the area where it may flow through the drainage as a narrow band of contamination manifested in well 265 (DOE, 2000). The upgradient extent of BRGFS vinyl chloride contamination is marked by wells 37 and 39. The southern extent of the plume was again defined by well OW-8. Vinyl chloride contamination was detected at 1.9 µg/L in well 45 having been absent in this completion since 2006.

Vinyl chloride was noted in pumping well 274 at 74.1 µg/L. Contamination was absent in all monitoring wells up and down gradient of the iron wall. The only well downgradient of pumping well 274 to detect vinyl chloride was pumping wells 277 and 278.

Of interest and lending credence to the possibility of enhanced biodegradation exists in the area of the cattails is the elevated level of vinyl chloride in well 265 and pumping well 275 in comparison to wells 45 and 77 or 182. Well 265 detected vinyl chloride at 118 µg/L while wells 77, 45 and 182 detected vinyl chloride at 44.1, 1.9 and 45.9 respectively.

The source of contamination in pumping wells 277 and 278 is not clear in that no contamination was present in any well downgradient of pumping well 274 during the second semi-annual event. However, the special sampling conducted in early 2012 in this area detected vinyl chloride in well 210L located at the south upgradient end of the iron wall at 7.8 µg/L, in 215L located just off the southern and eastern downgradient edge of the wall at 2.5 µg/L and well 243L immediately downgradient of well 215 but upgradient of wells 277 and 278 at 8.9 µg/L. Neither TCE nor 1,2-DCE were detected in any of the wells sampled. This data suggest that a small amount of vinyl chloride flows around the south end of the iron wall toward the interceptor trench housing pumping wells 277 and 278. However, these detections do not explain the presence of 1,2-DCE in pumping well 278.

The downgradient extent of vinyl chloride contamination over site clean-up standards was marked by compliance point wells 277 and 278.

2.7.2.7 1, 1 Dichloroethene, Upper Completion Wells

1,1-DCE was again present only in well 37 at 15.5 µg/L (Fig. 2.12). This result is consistent with that noted in previous years. No other 1,1-DCE upper completion contamination was noted in BRGFS monitoring wells.

2.7.2.8 1,1 Dichloroethene, Lower Completion Wells

1,1-DCE contamination in BRGFS lower completion wells runs from wells 67 and 37 in the area of the Old Ponds eastward through monitor well 45 (Fig. 2.13). Concentrations of 1,1,-DCE range from a high of 13.8 µg/L in pumping well 273 to 1.5 µg/L in monitoring well 45L. Well 45L again marks the downgradient extent of 1,1-DCE contamination. No 1,1-DCE was detected in pumping well 274 just downgradient of well 45L. The site cleanup standard for 1,1-DCE at the KCP is 7 µg/L. 1,1–DCE lower completion contamination plume shape was modified in 2011 with the sampling of monitor well 67 north of well 37. The 1,1-DCE concentration in this well was over the site clean-up standard as were concentrations in pumping wells 272 and 273.

A localized area of 1,1-DCE contamination was noted in well 137 just east of Building 16 at 5.3 µg/L.

2.7.2.9 1,1-Dichloroethane, Upper Completion Wells

1, 1-DCA was detected in upper completion well 137 at 7.9 µg/L (Fig. 2-14). No other 1,1-DCA contamination was noted.

2.7.2.10 1,1 Dichloroethane, Lower Completion Wells

1, 1-DCA contamination was noted in well 137 at 22.6 µg/L and is likely derived from residual contamination from the South Lagoon or a historical release at the south end of Building 16. (Fig. 2.15).

The 1,1-DCA plume was also manifested by contamination in monitoring wells 18, OW-8 and pumping wells 272 and 273 at concentrations ranging from 5.6 to 16.4 µg/L. All detections of 1,1-DCA in the BRGFS lower completion wells were below the site clean-up standard of 810.

2.8 Summary

Compliance point wells 277 and 278 continued to contain vinyl chloride over the site cleanup standard of 2 µg/L in 2011 with results ranging from 2.6 to 77.4 µg/L, respectively. 1,2-DCE was also detected over site standards in well 278. However, these wells also mark the downgradient extent of contamination over site clean-up standards. No contamination was detected over site standards downgradient of the BRGFS compliance point wells.

The northern extent of BRGFS contamination over site standards was marked by pumping well 275 which detected vinyl chloride at concentrations up to 60.6 µg/L and 1,2-DCE up to 242 µg/L. A small area of vinyl chloride and 1, 2-DCE contamination was noted in monitoring wells 265, 200 and 267 immediately north of the cattail area. This contamination is effectively captured by pumping well 275.

1,2-DCE was detected in four wells along the Blue River at concentrations at or less than 1.5 µg/L, well below the site cleanup standard of 70 µg/L. These wells sporadically detect 1,2-DCE.

TCE in the BRGFS remained confined to the Old Ponds area. The absence of the compound at locations significantly downgradient of the original release areas and the presence of TCE degradation products at these downgradient locations is indicative of the age of the release and the significant attenuation that occurs at the site. It is also consistent with the site conceptual model as discussed in Section 1.4.1.