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January 29, 2015 Reference No. 011725-12

Mr. Steve Martindale, P. Eng.
West Central Region
Ministry of the Environment and Climate Change
119 King Street West, 12th Floor
Hamilton, Ontario
L8P 4Y7

Dear Mr. Martindale:

Re: East Side Surficial Soil and Groundwater Investigation Work Plan
Chemtura Canada Co./Cie (Chemtura)
Elmira, Ontario (Site)

In response to your request to Chemtura in a letter dated October 29, 2014, please find attached the "East Side Surficial Soil and Groundwater Investigation Work Plan". This Work Plan provides details of the work Chemtura plans to complete to address data gaps identified in surficial soil and shallow groundwater quality data along the eastern and southern Site boundaries. Conestoga-Rovers & Associates (CRA) has prepared this Work Plan on behalf of Chemtura.

Should you have any questions, please do not hesitate to contact us.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Alan Deal, P. Geo.

AD/cb/8
Encl.

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Final Report

East Side Surficial Soil and Groundwater Investigation Work Plan

Chemtura Canada Co./Cie
Elmira, Ontario

Prepared for: Chemtura Canada Co./Cie

Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario N2V 1C2

January 2015 • 011725 • Report No. 27

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Section 1.0 Introduction

In a letter to Jeff Merriman dated October 29, 2014, the Ontario Ministry of the Environment and Climate Change (MOECC) requested the following:

> *At previous CPAC meetings, there has been focus on validation of environmental soil conditions on and off the eastern and southern borders of Chemtura property. The ministry requests that you to proceed with planning and implementing a soil sampling project on the east/south border of your property. Please share the sampling plan as soon as possible to permit the ministry to determine the extent of audit sampling we may undertake.*

Chemtura responded to the MOECC requests in a letter to MOECC dated November 27, 2014. Chemtura committed to providing a work plan to MOECC for the on-Site investigation of surficial soil and groundwater quality with respect to southern and/or eastern contaminant migration. This Work Plan provides a review and evaluation of existing hydrogeologic and soil quality data for the east side of the Site and includes an assessment of the potential for off-Site migration of contamination to the east or to the south. The data review focuses on data collected along the eastern and southern Site boundaries. The goal of this data review is to identify any data gaps so they can be addressed in the east side surficial soil and groundwater investigation.

Section 2.0 Conceptual Hydrogeologic Model

2.1 Introduction

This section provides a summary of the conceptual hydrogeologic model for the Site with particular emphasis on the east side of the Site and historic waste management practices. A complete review of the conceptual hydrogeologic model was previously provided in the Optimization Study (CRA, May 2001). The conceptual hydrogeologic model was updated for the Revised Nitrogen Species Report (CRA, September 2003) and again for the Groundwater Flow and Contaminant Transport Model Update (CRA, November 2012). CRA has used new information on hydrogeologic conditions at the Site or in the Elmira area to update the conceptual hydrogeologic model periodically and these updates are provided in the appropriate Chemtura Annual Monitoring Reports.

2.2 Hydrostratigraphy

Figure 2.1 provides a schematic of the conceptual hydrogeologic model of the various aquifers beneath the Site and the Elmira area. They are, in descending order:

1. The Surficial Aquifer (SA)
2. The Upper Aquifer (UA):
   a) the top beds of the Upper Aquifer (UA_1)
   b) the bottom beds of the Upper Aquifer (UA_3)
3. The Municipal Aquifer (MA):
   a) the Upper Municipal Aquifer (MU)
   b) the Lower Municipal Aquifer (ML)
4. The Bedrock Aquifer (Bedrock)

This typical stratigraphic sequence is not present beneath the northeast portion of the Site. Most of the overburden in the northeast portion of the Site is composed of a sequence of silt or silty clay till. Most of the aquifers listed above either pinch out beneath the northeast portion of the Site or become thinner and finer grained. Also, an unconfined shallow aquifer, the Surficial Aquifer (SA), is present in the extreme northeast corner of the Site. This is the only location where the SA occurs.

Stratigraphic data collected during the numerous investigations conducted since 1981 were used to construct a series of cross sections through the east side of the Site. Figure 2.2 is a cross section location map and Cross Section A-A' through D-D' are shown on Figures 2.3 through 2.6.

The following describes the stratigraphic and hydrogeologic information that form the basis of the conceptual hydrogeologic model.

The stratigraphy encountered along the eastern Site boundary illustrates the transition from the "typical" sand and gravel dominated stratigraphic sequence beneath most of Elmira and the silt till dominated stratigraphic sequence beneath the northeast portion of the Site. At monitoring wells OW15, OW24, and OW14 (Figure 2.6a Cross Section D-D'), located in the southeast portion of the Site, the MU and the ML are present. They consist of two separate layers of coarse, poorly graded sand and gravel approximately 2 metres (m) and 4 to 5 m thick, respectively. While present, the MU and ML beneath the southeast portion of the Site are much thinner than the 10 to 20 m of sand and gravel present in some off-Site areas, like near

E7. The UA is also present at these locations and at OW14 and OW15 it is separated into UA_1 and UA_3 by a layer of silt or silt till, the UA_2.

Figure 2.6b (Cross Section D-D') shows the hydrogeology along the central portion of the eastern Site boundary. The UA is not present at OW37. Farther north at OW8, OW38, OW34, and OW32 there is a shallow sand layer. Based on the east west cross sections through this area (described below) this shallow sand does not appears to be connected to the UA. Continuing north along the eastern Site boundary this shallow sand pinches out and is replaced by a sequence of silt and clay till at OW28, OW26, OW39, and OW164. There are several lenses of typically fine grained and/or silty sand, which are typically less than 1 m thick, in the upper 10 m of the stratigraphic sequence. These do not appear to be connected to each other, or the UA. Most of the wells installed along this portion of the eastern Site boundary are less than 10 m deep so there is limited information about the MU and ML. The MU pinches out to the north, somewhere between OW8d and OW164.

Chemtura installed UAT monitoring well OW164-10 in 2007 to investigate groundwater quality in the vicinity of RPE-3. In the "Investigation of RPE-3 Waste Material" Report (RPE-3 Report, CRA, August 2007), CRA recommended the installation of monitoring well OW164-36 to determine if the MU is present in the vicinity of RPE-3. Chemtura installed monitoring well OW164-36 adjacent to UAT monitoring well OW164-10 on December 15, 2009. Figures 2.5 and 2.6b (Cross Sections C-C' and D-D') are drawn through the northeast portion of the Site and include monitoring wells OW164-10 and OW164-36. The stratigraphic sequence near OW164-36 is not typical of most of the rest of the Site because the UA and MU are absent and the ML is less than 1 m thick. Monitoring well OW164-36 was installed in a sand layer that is approximately 0.3 m thick that corresponds to the typical elevation of the ML.

In July 2010, Chemtura collected groundwater samples from monitoring wells OW164-36 and OW164-10, and analyzed them for dense non-aqueous phase liquid (DNAPL)-related compounds. Organic carbon, petroleum hydrocarbons, pesticides and semi-volatile organic compounds (SVOCs) were detected in groundwater samples collected from OW164-10 but none of these compounds were detected in the groundwater sample collected from OW164-36. Volatile organic compounds (VOCs) and dioxins and furans were detected in the groundwater sample collected from OW164-36, but typically at concentrations one or two orders of magnitude less than the concentrations of these compounds in the groundwater samples from OW164-10. The reduction in frequency of detection and concentration of contaminants with depth in groundwater samples collected from OW164-10 and OW164-36 indicate the aquitard material overlying the ML in the former RPE-3 area has limited downward contaminant migration.

In 2010, CRA installed pressure transducers in OW164-36 and recorded the groundwater elevations in OW164-36 for a period of approximately one month to determine if the sand lens at OW164-36 has a hydraulic connection to the MU or the ML. During this monitoring period, Chemtura shut down all the extraction wells during a planned power outage. The OW164-36 groundwater elevation responded to the cessation of groundwater extraction by slowly rising approximately 0.1 m. There was less than 0.1 m of recovery when pumping resumed. Response in other portions of the ML was much greater and quicker. This demonstrates that the thin sand layer at OW164-36 is hydraulically connected to the ML, but the hydraulic connection is not as strong as in other parts of the ML.

The typical stratigraphic sequence beneath the Site is observed at monitoring well nest OW43, shown on the southern portion of Figure 2.5 (Cross Section C-C'). Both UA_1 and UA_3 are present adjacent to Canagagigue Creek. The UAT separates the UA_3 from the MU, which is in turn underlain by the MAT, ML, and Bedrock. To the east, the ground surface rises to an elevation of over 350 m above mean sea level (AMSL). The typical stratigraphic sequence is not present beneath the northeast portions of the Site where the surface elevation is greater than approximately 350 m AMSL. As shown on Figures 2.3 (Cross Section A-A'), 2.5 (Cross Section C-C') and 2.6b (Cross Section D-D') both the UA_1 and UA_3 pinch out where the ground surface rises above approximately 350 m AMSL. Here, the UA is replaced by a thick sequence of silt and clay till. There are sandy interbeds in this till sequence, but they do not appear to correlate with UA_1 or UA_3. The SA overlies the silt and clay till and is shown on Figures 2.5 (Cross Section C-C') and 2.6c (Cross Section D-D'). The SA does not appear to extend to the east of the Site as it is not present at CH-57. Similarly, the MU is not present beneath the northeast portion of the Site and the ML appears to have transitioned to a thin bed of silty sand. The MU is not present at all at CH-57, immediately east of the Site.

As shown on Figure 2.3 (Cross Section A-A') thin (0.3 m) beds of silty sand are present at an approximate elevation of 348 m AMSL at both boreholes BH4-07 and BH5-07. Sand is also present at a deeper horizon at these boreholes, approximately 344 m AMSL. A similar sequence of sand beds is shown on Figure 2.5 (Cross Section C-C') at boreholes BH10-07 and BH11-07. At approximately 346 m AMSL, up to 1 m of poorly graded fine to medium grained sand was observed at BH10-07 and BH11-07. As shown on Figure 2.5 (Cross Section C-C'), these sand beds may be laterally continuous and connected to thin sand seams encountered during the drilling of boreholes BH5-07 and BH6-07.

The northeast portion of the Site has a different hydrogeologic regime than the rest of the Site and most of Elmira. In general, where the ground surface elevation exceeds 350 m AMSL the shallow geology is dominated by silty or clayey till, not the coarse grained alluvial deposits present beneath the rest of the Site. There are no well-developed aquifers in the northeast portion of the Site. The SA is perched and discharges to the west in a swampy area near the

centre of the Site. Thin sand seams are present in the silt dominated sequence beneath the northeast portion of the Site but they are discontinuous and do not appear to be connected with the UA. Some deeper sand lenses, like the one at OW164-36, exhibit a weak hydraulic connection to the MA but they are not the typical thick sequence of sand and gravel present in other areas.

2.3 Shallow Groundwater Flow

Figure 2.7 shows the groundwater elevation contours for the SA based on data collected on September 9, 2014. SA groundwater typically flows west, northwest, or southwest towards the swampy area between the SA and Canagagigue Creek. SA groundwater flowed west on September 9, 2014.

Figure 2.7 also shows UA_1 groundwater elevation contours beneath the entire Site. East of Canagagigue Creek, UA_1 groundwater generally flowed west towards the Creek. As a result, groundwater discharged into the Creek along the northern reach of the eastern Creek bank. South of monitoring well OW141-2 the surface water elevation is higher than the corresponding groundwater elevation. Groundwater does not discharge into Canagagigue Creek along the southeastern Creek bank. This is a seasonal condition with the discharge zone extending farther south in the summer months.

Groundwater elevations for wells completed in silt and or clay till are also presented on Figure 2.7. Groundwater elevation contours are not provided for the northeast corner of the Site because there is not a coherent horizontal groundwater flow regime and UA_1 is not present beneath this portion of the Site. Groundwater in the fine-grained deposits does not flow uniformly like it does in the permeable aquifer material. Vertical gradients and fractures within the clays may be the dominant groundwater flow component beneath this area of the Site.

Section 3.0 Waste Management History

3.1 Introduction

Information used for this section of the report was obtained from the following sources:

- A History of Uniroyal Waste Management at Elmira (W. Jackman *et al.*, March 1985)
- A Summary of Our Products and Our History, Uniroyal Chemical Division of Uniroyal Ltd., Elmira, Ontario, (date unknown)
- Transcriptions from Appeal of August 28, 1990 Control Order, Volumes 8-11
- Interviews with retired Uniroyal employees familiar with historical waste disposal practices

- Aerial photographs
- CRA, "Feasibility Study – Buried Waste", July 1990
- CRA, "Environmental Audit – Phase I Report", August 1991
- CRA, "Status Report – Buried Waste Remediation", August 1991
- CRA, "Final Report – Buried Waste Containment Project", February 1994
- CRA, "Historic Waste Management Units", May 2001
- CRA, "Dense Non-Aqueous Phase Liquids (DNAPL) Occurrence Status Report, October 2005
- CRA, "DNAPL Investigation Work Plan", November 2006
- CRA, "Investigation of RPE-3 Waste Material", August 2007
- CRA, "Buried Waste Removal – Former RPE-3 Area", January 2010
- CRA, "Former Gravel Pit Area Investigation", March 2012
- CRA, "Remediation and Capping of Former Gravel Pit Areas (GP-1 and GP-2), December 2014

Figure 3.1 shows the location of the former waste management areas. Table 3.1 provides a summary of the former waste areas. This section provides details of the material placed in the waste management areas, waste management practices and subsequent remediation. Chemical production at the Site has been ongoing since 1942. Production of aniline and diphenylamine for use in stabilizers for explosives in World War II commenced at the request of the Canadian government. Production of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) began in 1945. A wide range of organic chemicals have since been manufactured at the Site.

The following summarizes the ownership history at the Site:

- US Rubber, formerly Dominion Rubber Co., Ltd. (in Canada) took ownership of the Site in 1939
- In 1965 US Rubber became Uniroyal, Inc.
- In 1985, the chemical division of Uniroyal Inc. was acquired by Avery Inc.
- In 1986 Uniroyal Chemical Company (UCC) was formed as a subsidiary of Avery Inc.
- In 1989 UCC Investors Holding bought Uniroyal Chemical from Avery, and became Uniroyal Chemical
- In 1996 Uniroyal Chemical and Crompton & Knowles merged
- In 2001 the company became Crompton Co.
- In 2006 the company became Chemtura Canada Co./Cie

Because the operations remained generally consistent throughout the ownership history, CRA cannot specifically confirm which entities were responsible for which historical operations. Therefore, from here on in, the above listed entities are collectively referred to as "Chemtura's Predecessors".

3.2 IR-1

IR-1 was located east of Canagagigue Creek, at the north end of the Site. Iron oxide sludge from aniline production was deposited on this part of the Site in the mid-1960s. The waste products from this aniline sludge consisted of iron oxide and other residual process wastes such as nitrobenzene. The materials deposited into IR-1 also contained some diphenylamine (DPA) tars.

The maximum depth of IR-1 is approximately 6 m, and the surface area of IR-1 is approximately 0.46 hectares. This portion of the Site was historically part of the Canagagigue Creek flood plain and was situated on the northern portion of the Site. Where IR-1 is located was historically a low-lying area that was filled in over time. Material deposition at IR-1 is evident on both the 1964 and 1967 photographs of the Site. Aniline was produced until approximately 1967. It is assumed that deposition of aniline sludges at IR-1 ceased when the production of aniline ended.

3.3 IR-2

IR-2 was located at the northeast portion of the Site, and was approximately 1.05 hectares in area. In August 1969, materials removed from RPW-6, RPW-7, and RPW-8 were spread in IR-2. In June 1970, aniline sludges were spread over this portion of the Site to a thickness of approximately 10 cm, allowed to dry and then were tilled into the soil. These sludges may have originated from RPW-6, RPW-7, and RPW-8 when they were cleaned out before being lined with clay in approximately 1970. The location of IR-2 on the northeast portion of the Site is evident on the May 1970 aerial photograph.

IR-2 was excavated in 1993 prior to construction of Building 60. During the excavation of the IR-2 soils, small pieces of black tar-like material were identified, which were placed in Building 60 and subsequently disposed of off-Site. The remaining material excavated from IR-2 was characterized as Controlled Fill under the then current "Proposed MOE Guidelines for Management of Excess Soil" and used as backfill for the RPE-4 and RPE-5 buried waste excavations.

3.4 East Pits

3.4.1 Introduction

The east pits consisted of the following: RPE-1, RPE-2, RPE-3, RPE-4, and RPE-5. RPE-1 was constructed between 1948 and 1953. Pits RPE-2, RPE-3, and RPE-4 were constructed between 1946 and 1948, after full-scale production of 2,4-D began. A fifth pit, RPE-5, was constructed south of the four initial pits between 1955 and 1962.

The east pits were estimated to be approximately 1.5 to 2 m in depth. As early as 1948, seepage along the western slopes of the east pits was known to occur. Seepage from these pits was directed overland in open ditches which drained to GP-1 and from GP-1 to GP-2 situated to the south.

In 1969 and 1970, Chemtura's Predecessors initiated a program to consolidate wastes and provide a secure on-Site disposal facility, under the direction of the Ontario Department of Health and the Department of Energy Resources Management. This consolidation entailed the removal of sludges from RPE-4 and RPE-5, lining RPE-4, and RPE-5 with woven polyethylene sheets, and then returning the above-mentioned sludges, together with other wastes, into these lined pits. These wastes included drums and contaminated soils from various Site disposal areas including: west side ponds RPW-3, RPW-4, RPW-5, RPW-6, RPW-7, and RPW-8; and east side pits RPE-2, and RPE-3; tars from TPE-1, TPE-2, TPW-1, TPW-2, RPW-4; and some drums from BAE-1, which were considered to be in poor condition and could not be transported off Site for disposal. RPE-1 was closed and covered over in the mid-1960s and the materials from this pit were not consolidated in RPE-4 and RPE-5.

Each of the above waste management units is discussed in more detail in the following sections.

3.4.2 RPE-1

RPE-1 was constructed between 1948 and 1953. The size of RPE-1 was approximately 0.25 hectares. It was used for disposal of 2,4-D wastewater, and also contained some polyester resins. RPE-1 was constructed on what was believed to be a sand lens and, as a result, the bottom of RPE-1 was porous and leakage of wastes contained in the pit was a problem. The sand lens may actually have been the SA. The deposited waste material leached out of the pit and caused vegetative stress along the Canagagigue Creek, as well as to the east of the pit. RPE-1 operated until the mid-1960s, when it was closed and backfilled. Specific details regarding the closure of this pit were not available for review. It is therefore, not known if impacted materials were removed from this area.

3.4.3 RPE-2, RPE-3 and RPE-4

These three unlined pits were constructed between 1946 and 1948 as waste water storage pits. Liquid wastes from aniline and nitrobenzene processing were pumped into RPE-2. These wastes were often acidic and contained aniline. In 1945, when the production of 2,4-D began, RPE-3 was excavated to hold 2,4-D waste liquids. RPE-3 was also used as a holding pond for waste water from the test production of dimethyl diethyl ether (DMDEE). RPE-4 was constructed to hold liquid wastes from the Thiokol process. After the Thiokol operation stopped, RPE-4 was used for spent acid from DDT production.

The pits did not have an outlet to Canagagigue Creek. Slow seepage through the clay was intended to neutralize the acidic wastes as well as filter contaminants. RPE-2, RPE-3, and RPE-4 were approximately 0.19, 0.22, and 0.24 hectares in area, respectively.

There were two pipelines from the plant to the east pits. One was a 2,4-D pipeline, and the other was a nitrobenzene pipeline. The original 2,4-D pipeline originated from the sump located in the northeast corner of Building 15 and was of wooden construction. An aboveground wooden line was constructed as buried steel lines became pitted and corroded from the outside by the aniline sludge fill on the Site. RPE-4 was the largest of the original pits, and the 2,4-D pipeline from Building 15 discharged into it. This pipeline is evident on the May 1948 aerial photograph of the Site. In the late 1940s, the aboveground wooden pipeline was replaced with a buried pipeline that was constructed beneath Canagagigue Creek. The construction details of the nitrobenzene pipeline are not known.

It is unclear how the wastewater from the 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) process was managed but it may have also been processed through RPE-2, RPE-3, and RPE-4. Wastewater sumps at the plant were periodically cleaned out and the solids and liquids from the sump cleaning were occasionally deposited into the east side ponds.

RPE-2, RPE-3, and RPE-4 worked independently of one another, and relied heavily on evaporation and soil seepage to reduce liquid volumes. Intermittent overflow from the pits was directed into open ditches or furrows that drained to a gravel pit on the southeast portion of the Site, i.e., GP-1. This seepage toward GP-1 continued until approximately 1965, when the Elmira Sewage Treatment Plant (STP) began to receive wastewater from the Site. At that time, most of the 2,4-D wastewater was diverted to the west ponds for pretreatment, and subsequent treatment at the Elmira STP.

After the Elmira STP was constructed, the east pits continued to be used to equalize the loadings to the Elmira STP. Excess 2,4-D wastewater was diverted to the east side ponds whenever the treatment capacity of the Elmira STP was reduced by cold temperatures or

excess inflows during the spring. When capacity was restored, the wastes would be diverted back to the Elmira STP.

As the December 1968 aerial photograph shows, RPE-2 was cleaned out and closed some time in approximately 1968. At this time, liquid waste was drained from RPE-2 into RPE-3 and RPE-2 was subsequently backfilled.

DMDEE wastes were reportedly pumped from RPE-3 and disposed of off Site in approximately July 1969. In August of 1969, the sludge was removed from east-side ponds RPW-6, RPW-7, and RPW-8 and reportedly stored in RPE-3. The liquid materials were then pumped into RPE-4 from RPE-3; although, this may have occurred as late as mid-1970. RPE-3 was then subsequently backfilled. Specific details regarding the closure of RPE-2 and RPE-3 are not available. In 2007, as part of an investigation of DNAPL on the east side of the Site, CRA identified commingled fill and waste material in the former RPE-3 area. In 2009, Chemtura returned to RPE-3 and excavated an additional 565 tonnes of commingled fill and waste from RPE-3. The fill and waste material were characterized and disposed of off Site as non-hazardous waste.

In 1970, contaminated solids from Shirt Factory Creek, west side ponds RPW-6, RPW-7, and RPW-8, TPE-2, drums from BAE-1 and contaminated soil from south of TPE-2 were excavated and placed into RPE-4 and RPE-5.

3.4.4 RPE-5

RPE-5 was constructed between 1955 and 1962 to replace RPE-1. Liquids are visible in RPE-1 in the mid-1960s aerial photography. The relationship between the continued operation of RPE-1 and the construction of replacement pit RPE-5 is unknown. The size of RPE-5 is approximately 0.4 hectares.

In 1969 and 1970, under the direction of the Ontario Water Resources Commission (OWRC) and the Ontario Department of Energy, Mines and Resources, a program was initiated to consolidate its wastes into RPE-4 and RPE-5. This consolidation entailed the removal of sludge from RPE-4 and RPE-5 waste pits, lining the pits with woven, mylar-reinforced polyethylene sheets, and replacement of the former sludges along with waste (including drums and contaminated soils) from other Site disposal areas. A temporary unlined disposal pit of unknown dimensions was constructed south of the pits while RPE-4 and RPE-5 were being constructed and fitted with the liners. RPE-5 was also expanded to include TPE-1. After RPE-5 was lined, it was used to dispose of waste from around the Site, including contaminated solids excavated from Shirt Factory Creek, wastes from RPW-3, RPW-4, RPW-5, RPW-6, RPW-7, RPW-8, RPE-2, RPE-3, RPE-4, RPE-5, TPE-1, TPE-2, TPW-1, and some drums from BAE-l. An

estimated 3,400 drums were disposed of in RPE-4 and RPE-5, the majority of which were disposed of in the south pit (RPE-5). These drums were in varying states of condition, and contained chlorophenolic wastes, polylite, 2,4-D wastes and polyester resins. The drums were used drums and were disposed of randomly in the pit.

In late 1990, a 30-mil low density polyethylene synthetic cap was installed over RPE-4 and RPE-5 to prevent infiltration into the pits.

In 1993 and 1994, approximately 5,794 cubic metres (m^3) of waste material was excavated from RPE-4, and approximately 14,726 m^3 of waste material from RPE-5 and stored the material in an on Site containment facility. The waste material that was excavated from RPE-4 and RPE-5 consisted of discoloured, solidified tar pieces, and included drums (whole and fragmented). The texture of the material was generally fine-grained, moist (with the exception of a small portion of RPE-5), and exhibited a moderate chemical odour. The waste material in RPE-5 was generally darker in colour, and had stronger chemical odours. A portion of RPE-5 was very wet. Subsequently, the wastes from the containment facility were removed (46,000 Tonnes) and disposed at a secure off-Site landfill in 1998 and 1999.

3.5 TPE-1 and TPE-2

Both TPE-1 and TPE-2 were created when the west side waste disposal areas were closed down and excavated in 1969 and 1970. TPE-1 and TPE-2 were unlined pits that held waste tars from the west side pits awaiting disposal into RPE-4 and RPE-5. The sizes of the two tar pits were approximately 0.05 and 0.06 hectares, respectively. Once the lining of RPE-4 and RPE-5 was completed in 1970, the wastes in TPE-1 and TPE-2 were consolidated in RPE-4 and RPE-5.

When RPE-5 was lined, it was expanded to include TPE-1. Where the waste tars from TPE-1 were stored in the interim has not been determined.

3.6 BAE-1

Drums were buried along the east side of the Creek for a period of approximately 10 years beginning in the early 1950s. Every year a hole the size of a railway boxcar was dug approximately 3.5 m in depth, and drums were deposited into it. The approximate size of BAE-1 was 0.15 hectares. Much of the drummed wastes in BAE-1 came from processes which were carried out in Building 15, including the production of chlorinated phenolic herbicides, such as 2-methyl-4-chlorophenoxyacetic acid (MCPA), and 2,4-D and its associated acids and esters.

Part of the 2,4,5-T production process typically involved the "washing" of the product with solvent to remove unwanted byproducts, which may have included 2,3,7,8-TCDD. Other solvents were used in the process and small amounts of wastewater were generated. The solvents used in this process were recovered in a distillation unit. The concentrated waste or "still bottoms" were drummed and buried in BAE-1, adjacent to the future location of RPE-4. From approximately 1950 to 1963, waste tars from the 2,4,5-T process were drummed and buried in pit BAE-1. Approximately 250 to 400 drums of residual tars were deposited in the pit.

In approximately 1955, the sludge from the general sump in Building 15 was collected and stored in 45-gallon drums, which were buried in pit BAE-1 in approximately 1959. The amount of sludge provided per year was between 8 and 17 m^3, or between 41 and 82 drums. Filter cake materials from the various chemical processes were also disposed of in this pit from 1950 to 1955.

In 1970, many of the drums were excavated and shipped to Sarnia for disposal. Drums that were not in good condition for shipment were disposed of in RPE-4 and RPE-5. Many of these drums contained as little as 12 litres (3 gallons) of waste, the remainder being water. Some of the drums were reportedly reburied in RB-1 and RB-2 as discussed in further detail below.

3.7 RB-1 and RB-2

These two areas were identified by Jackman as locations of re-buried drums from the excavation of BAE-1 in approximately 1970. The sizes of RB-1 and RB-2 were approximately 0.08 and 0.06 hectares, respectively and they were generally within the footprint of the former BAE-1. In 1987, the remaining drums in RB-1 and RB-2 were excavated and the materials removed for off-Site disposal. Each disposal cell was excavated with a backhoe, and the drums were removed from the pit. Liquid wastes were removed from the drums and placed in on-Site storage tanks. This liquid was then disposed of off Site. Once liquids had been removed from the drums, they were crushed and placed in lugger boxes for off-Site disposal. Contaminated soils were also excavated and put in these lugger boxes. By October 16, 1987, approximately 1,931 drums had been excavated. In addition, approximately 1,062 cubic yards of solid materials had been removed. Some of the materials excavated from RB-1 and RB-2 included the following: filter cake material, spent carbon, pesticide and water mixtures, plant refuse including plastic sheeting, tubing, containers, rags, filter cloths, 2,4-D sludge, 2,4-D and water, 2,4-D third phase, solvents and chlorophenols.

3.8 GP-1 and GP-2

Seepage, overflow and storm water runoff from the pits RPE-1 to RPE-5 was directed by drainage ditches or furrows into gravel pits (GP-1 and GP-2) located in the southeast portion of

the Site. To prevent overflow of the RPE and BAE-1 waste pits from discharging to the west and into the Creek, Chemtura's Predecessors plowed furrows to direct the surface liquids from waste pits to the gravel pits. This practice began in the early 1940s and continued until approximately 1970, when the east side ponds were closed and/or lined. Liquids would pool in the gravel pits and eventually seep down into the subsurface soils.

The gravel pits reportedly contained standing liquids until approximately 1969 and 1970 when the RPE and BAE-1 waste pits were closed. Without an ongoing source of liquid to replenish the gravel pits, the gravel pits dried up. The areas of the standing water In GP-1 and GP-2 were approximately 0.23 and 0. 6 hectares, respectively based completion of a topographic survey. Based on the topography of the Site, the location of the remaining furrow or ditch and the relative locations of the gravel pits with respect to the waste pits (GP-1 was north and uphill of GP-2), CRA suspects that the majority of the overflow from the waste pits entered GP-1 rather than GP-2.

In 2013 and 2014, Chemtura completed remediation work in this area to reduce the quantity of soil impacted with dioxins and furans and to reduce the potential exposure risks to human and ecological receptors. During this time, Chemtura excavated 3,611 m^3 of the most heavily impacted soil from GP-1, and disposed of the soil off Site as non-hazardous waste material. Chemtura also imported 12,378 m^3 of clean topsoil to use as backfill and to use as a soil cover in GP-1, GP-2, and the southeast area. The clean topsoil, which is a minimum of 0.3 m in thickness across all of GP-1 and GP-2, and much of the southeast area as a whole, eliminates the exposure risks through direct contact with impacted soil remaining in situ.

Section 4.0 Surficial Soil Quality

Based on the Site history, Site topography, and previous analytical results, CRA conceptually divided the east side area into three distinct zones as follows:

- Former Waste Disposal Areas: Includes eastern Site boundary to east of former waste pits near the topographic high point of the Site and specifically includes the locations of IR-2, RPE-1, RPE-2, RPE-3, RPE-4, RPE-5, RB-1, RB-2, TPE-1, TPE-2, and BAE-1.
- Wetland Area South of RPE-5: Includes eastern Site boundary in low lying area to the south of the former waste pits in small woodlot area. No known waste disposal activities occurred in this area.
- GP-1, GP-2, and Southeast Area: Includes the former GP-1 and GP-2 gravel pits and the floodplain area in the southeast corner of the Site. GP-1 was the end point of overflow from the former east side waste pits.

The following subsections discuss the applicable reference criteria, contaminants of concern (COC), and rationale for proposed soil sample locations in each of these three areas.

4.1 Applicable Criteria

In 2003, CRA completed a Site Specific Risk Assessment (SSRA) which included both a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA). These identified potential risks for humans and ecological receptors due to exposure to soil on the east side of the Site, and estimated the potential risks based on these potential exposures. The SSRA was used to establish human health risk based criteria (Human Risk Criteria) and Ecological Risk-Based Criteria (Ecological Risk Criteria). Details of how these criteria were derived are provided in CRA's Human Health Risk Assessment, dated February 2003, and CRA's Ecological Risk Assessment, dated July 2003.

CRA has previously compared the results of surficial soil samples collected from the east side of the Site to both the Human Risk Criteria and the Ecological Risk Criteria. However, the derivation of the Human and Ecological Risk Criteria were based on assumptions applicable to receptors on the Site itself, which is an industrial property. As the neighbouring property includes a residential dwelling and is used for agriculture, the receptors and associated exposure risks are more sensitive. Therefore, neither the Human nor Ecological Risk Criteria are appropriate to assess exposure risks to receptors on the neighbouring property for the purpose of this Site boundary investigation. Therefore, for the purpose of investigating the south and east side Site boundaries, CRA will assess concentrations of samples collected to more applicable reference criteria.

Specifically, the surficial soil results will be compared to the generic standards provided in the Ministry of the Environment and Climate Change (MOECC's)[1] document entitled "Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act", dated April 15, 2011 (hereafter referred to as the MOECC Standards). The MOECC Standards provide generic soil and groundwater quality standards for certain chemicals based on a combination of the following Site-specific conditions:

- *Environmental Sensitivity* – CRA reviewed the Ontario Ministry of Natural Resources' "Natural Heritage Information Centre" database to identify areas registered as Areas of Natural or Scientific Interest (ANSI) within a 1-kilometre (km) radius of the Site to identify

[1] Prior to June 24, 2014 the Ministry of the Environment and Climate Change was called the Ministry of the Environment.

any sensitive areas in accordance with Section 41 of O. Reg. 153/04. There are no ANSI locations within 1 km of the Site.

- *Shallow Soil Property* – More than 2 (m) of overburden soil exists on the Site and, therefore, it is not considered a shallow soil property.
- *Water Body* – Parts of the southeast corner of the Site (i.e., former gravel pit area) are located within 30 m of a water body, i.e., the Canagagigue Creek (Creek).
- *Property use* – The Property use is industrial; however, the neighbouring property use to the south and east is used for residential and agricultural purposes. No change in land use is currently proposed.
- *Restoration of Groundwater Quality* - The Site is located near the eastern edge of the Town of Elmira, and the groundwater within 1 km of the Site is used for potable purposes. Therefore, a potable groundwater condition is applicable for the Site.
- *Restoration Depth* - For comparative purposes, results were compared to the full depth standards.
- *Soil Texture* – The texture of the soil varies across the Site. Soil grain size tests indicate that the predominant soil texture at the Site is coarse textured. Comparison to coarse textured soil criteria is generally more conservative.

Based on the analysis above, CRA compared the soil and groundwater analytical results obtained during the development of this Work Plan to the following standards:

- Table 2 Full Depth Site Conditions Standards for Agricultural[2] Property Use (Table 2 Standards) in the Former Waste Disposal Area; and in the vicinity of the Wetland Area South of RPE-5
- Table 8 Full Depth Site Conditions Standards for Residential Property Use Within 30 m of a Water Body (Table 8 Standards) in the investigated areas in the vicinity of GP-1, GP-2, and the Southeast Area

Although groundwater is shallow (i.e., less than 1 m below ground surface [bgs]) in the southeast area of the Site, as the COCs are primarily non-volatile, the most likely mechanism for contaminant transport would be overland flow. Therefore, the Table 8 Standards are most applicable and most conservative for use in this investigation.

[2] Selected as the most sensitive land use applicable to the adjacent property.

4.2 Contaminants of Concern

As discussed, CRA completed an HHRA and ERA to identify potential exposure pathways for humans and ecological receptors to soil on the east side of the Site, and to estimate the potential risks based on these potential exposure pathways. Based on the nature of operations during the time waste was historically disposed of on the east side, and the potential receptors, the primary COCs in the surficial soil on the east side of the Site were identified as polychlorinated dibenzo-para-dioxins and, polychlorinated dibenzofurans (dioxins and furans), and dichlorodiphenyltrichloroethane (DDT).

Although the primary COCs that had been identified included DDT and dioxins and furans, the specific nature of the wastes that were directed to and comingled in the former waste pits was not known. In 2007, after identifying waste material in RPE-3, CRA collected samples of the waste material observed. The limited quantities of the waste types limited the amount of sample collected, and thus, limited the analyses. A brief description of the waste types observed and the parameters for which each waste type was analyzed is presented below:

Sample Location	***Sample Matrix***	***Analyzed parameters***
TP5-07	Commingled fill and waste material	Total organic carbon (TOC), VOCs, open scan[3] VOCs, open scan SVOCs, PHC, herbicides/pesticides, dioxins & furans
TP9-07	Fill material	TOC, VOCs, open scan VOCs, open scan SVOCs, PHC, herbicides/pesticides, dioxins & furans
TP5-07	Tar	Open scan SVOCs

Although this waste material was excavated from former RPE-3 and disposed of off-Site in 2009 (as discussed previously), the characterization of waste material that was identified in RPE-3 provides useful data for the purpose of determining parameters to be investigated. The following presents the results in which concentrations of analyzed parameters from these samples were greater than the Table 2 Standards:

[3] Open scan analysis completed to broaden the parameters that could be analyzed for each group.

Sample Location	*Parameter*	*Concentration (µg/g)*	*Table 2 Standards (µg/g)*	*Sample Depth (m)*
TP5-07	Benzene	0.5	0.21	3
	Petroleum Hydrocarbons (PHC)(F2)	470	98	
	PHC(F3)	4,300	300	
TP9-07	Chlorobenzene	25	2.4	3
	Ethylbenzene	3	1.1	
	Toluene	62	1	
	2,4-Dichlorophenol	46.9	0.3	
	2,4,5-Trichlorophenol	30.2	4.4	
	PHC(F2)	2,900	98	
	PHC(F3)	3,600	300	
	Dioxins/Furans	22,800 (pg TEQ/g)	13 (pg TEQ/g)	

Therefore, based on the historic operations at the Site, and characterization of waste material from RPE-3, the following parameters have been selected as COCs that will be investigated along the Site boundary: dioxins, furans, organochlorine pesticides (OC pesticides) (including DDT, 2,4-D, and 2,4,5-T), chlorophenols, PHC, and VOCs.

In 2001, 2002, and again in 2011, CRA investigated portions of the east side of the Site for DDT, dioxins, furans, and to a limited extent, OC pesticides (all parameters), and VOCs. There are no additional data regarding chlorophenols or PHC on the east side of the Site.

The following subsections includes a discussion of the extent and maximum concentrations with respect to DDT, dioxins and furans, and VOCs in the soil within close proximity to the Site boundary in each of the three conceptual areas identified previously. Assessment of samples collected previously within close proximity of the Site boundary provides useful information for the purpose of scoping the investigation. Figure 4.1 shows the three conceptual areas, previous sample locations, and proposed new surficial soil sample locations.

4.3 Former Waste Disposal Areas

This area includes the northeastern portion of the Site, east of the former waste pits, and extends for approximately 550 m along the northern Site boundary. On January 9, 2015, CRA inspected the eastern Site boundary with a specific focus on assessing potential drainage patterns from the east side of the Site to off-Site receptors. Although the ground was snow

covered at the time of the inspection, the topography fairly clearly indicates that the preferential pathway from the former waste pits is to the west and then to the south towards GP-1 (not to the east towards the neighbour's property), across most of the east side. Near the top of the hill in the area of RPE-1 and RPE-2, there is a gentle slope to the east towards the neighbouring property. However, the grade is far greater towards the south from these former waste pits, such that overflow would be more likely to flow to the south. Further, the slope to the east is shallow enough that most overflow would likely have infiltrated on Site rather than moving via sheetflow. This hypothesis is consistent with what former employees of Chemtura's Predecessors have stated, in that liquids were directed from these waste pits to the GP-1 area of the Site.

The former RB-1, RB-2, and BAE-1 waste pits are situated on the eastern Site boundary. The topography slopes to the southwest in this area (towards GP-1). Former employees of Chemtura's Predecessors have indicated that overflow from these waste pits was also directed to GP-1.

There are limited data available regarding the concentrations of DDT in the surficial soil in this area of the Site. CRA collected one sample (S-1) in 2001 from the surficial soil in the former RPE-1 area (approximately 45 m from the Site boundary). The concentration of DDT was 0.577 µg/g, which is less than the Table 2 Standard of 1.4 µg/g.

In 2001 and 2002, CRA collected several samples from within 50 m of the Site boundary that were analyzed for dioxins and furans. These results were reported as the Total Toxic Equivalent Quantity (TEQ) concentration[4]. The TEQs in soil samples collected from within 50 m of the Site boundary, as compared to the Table 2 Standards are presented below:

[4] In accordance with the 2005 World Health Organization, Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds WHO (2005). The Total Toxic Equivalency (TEQ) value reported is the sum of Toxic Equivalent Quotients for the congeners tested. The toxic effects of dioxins are measured in fractional equivalencies of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), which is the most toxic and best studied member of its class. 2,3,7,8- TCDD has a TEQ of one.

Location	*Table 2 Standards (All Uses) (*pictogram/gram [*pg/g]*)	*Measured TEQ (pg/g)*	*Sample Depth (m bgs)*	*Distance from Site Boundary (m)*
S-20(02)	13	1,137	0 – 0.15	10
S-1(01)		288.93	0 – 0.15	45
S-21(02)		50.5	0 – 0.15	50
S-23(02)		51.7	0 – 0.15	45
S-24(02)		2,179	0 – 0.15	45

Previously, samples have been biased towards the surficial soil surrounding the former waste pits themselves, and therefore, the data at the Site boundaries are limited.

There have been no surficial soil samples submitted for analysis of VOCs, chlorophenols, or PHC in this area of the Site.

To address the data gaps, CRA will collect nine surficial soil samples from this area. CRA will focus the soil sample locations towards areas with the highest potential of impact. This includes five soil sample locations east of RB-1, RB-2, and BAE-1, which were located on the Site boundary. CRA will also collect one soil sample from immediately east of IR-2, near where S-20(02) was collected. CRA will then collect three additional soil samples from locations to the east of the former RPE-1, 2, 3, and 4 waste pits. These three samples will be spaced evenly throughout this area (approximately one sample per every 90 m) and will be biased to areas where the slope to the east is greatest or preferential flow pathways exist or may historically have existed based on aerial photographs. CRA will collect composite soil samples from the upper 0.15 m of soil within 1 m of the Site boundary and will submit the soil samples for analysis of dioxins, furans, chlorophenols, and OC pesticides. As DDT and dioxins and furans tend to sorb tightly to fine grained soil particles and are not readily soluble in water, sampling of the upper 0.15 m of soil is most conservative. This is also supported by information published by United States Environmental Protection Agency[5] on dioxins and furans (2,3,7,8-TCDD), which states:

> "*If released to soil, TCDD is not expected to leach. As a rule, the amount of TCDD detected more than 8 cm below the surface has been approximately 1/10 or less than that detected down to 8 cm.*"

[5] Technical fact sheet on DIOXIN (2,3,7,8-TCDD), last accessed on October 15, 2014 at http://www.epa.gov/ogwdw/pdfs/factsheets/soc/tech/dioxin.pdf.

CRA will also submit a subset of these samples (up to three) for laboratory analysis of VOCs and PHC. These locations will be selected based on evidence of visual and olfactory evidence of impact, and based on field screening with a photo-ionization detector (PID).

4.4 Wetland Area South of RPE-5

There is a topographical low point to the south of RPE-5. There were no known waste disposal areas in this portion of the Site, and this area currently sustains a small woodlot and a wetland area. As discussed previously, previous employees of Chemtura's Predecessors stated that liquids from the former waste pits would be discharged through furrows to the southeast corner of the Site. During a Site inspection on January 9, 2015, CRA identified what appeared to be one of the furrows from the former waste pits to GP-1. The size and orientation of the furrow were consistent with what is evident in the 1955 aerial photo. The furrow was approximately 50 m from the Site boundary and clearly extended from the north end of the waste pit area straight into GP-1. Between the former waste pits and the gravel pits, the furrow is visibly lower in elevation than the neighbouring property to the east, such that liquid from the furrow could not reach the neighbouring property to the east even under very high flows. There is no swale, furrow, or ditch that connects the waste pits to the wetland in the woodlot on the property immediately east of the Site. In addition, there is no connection between the on-Site wetland and the neighbouring property. However, there are limited data between the eastern Site boundary and the furrow.

Specifically, there have been no samples previously collected that have been submitted for analysis of chlorophenols, DDT, or VOCs from this area, and there are limited data regarding the dioxin and furan concentrations of DDT in the surficial soil in this area of the Site. One sample (S-17(02)) was collected by CRA in 2003 from the surficial soil approximately 30 m from the Site boundary. The dioxin and furan Toxic Equivalency Quotient (TEQ) was 10.1 pg/g, which is less than the applicable Table 2 Standard of 13 pg/g.

To address the data gaps, CRA will collect three surficial soil samples from this area. As there are no known former waste disposal pits in this area, CRA will space the sample locations evenly throughout this area (approximately one sample per 30 m). CRA will collect composite soil samples from the upper 0.15 m of soil within 1 m of the Site boundary. To investigate the potential for a preferential pathway from the historic furrows to the Site boundary, CRA will also collect an additional three samples perpendicular to the east Site boundary. These three surficial soil sample locations will be collected from low lying areas on the Site, between the northernmost end of the drainage ditch on the neighbouring property, and the historic furrows between the former waste pits and GP-1. CRA will submit the soil samples for analysis of dioxins, furans, DDT, and chlorophenols. Additionally, CRA will submit one of these samples for

laboratory analysis of VOCs and PHC. This location will be selected based on evidence of visual and olfactory evidence of impact, and based on field screening with a PID.

4.5 GP-1, GP-2, and Southeast Area

This area is the topographical low point of the Site and is situated within the floodplain of the Creek. The topography in the southeast area slopes to the southwest towards the Creek. There is a gentle downward slope from former GP-1, which was the historic receiver of liquid wastes overflowing from the waste pits on the east side of the Site. However, there is a steep embankment (pre- and post-remediation topography) that would make it virtually impossible for waste liquids to reach the Stroh property. As the general topography slopes to the southwest (towards the Creek) in this area of the Site and the southern and western edges of GP-1 were historically lower than the eastern edge, any liquids overtopping the embankment of GP-1 would be directed to the south towards GP-2 or to the east toward the floodplain of the Creek.

CRA has completed extensive investigations in 2001, 2002, and again in 2011 to characterize the soil conditions in this portion of the Site. In 2013 and 2014, Chemtura undertook remediation work to excavate surficial soil from GP-1 (i.e., the soil most heavily impacted with dioxins, furans, and DDT) from the Site and to place a 0.3 m vegetated soil cover over GP-2 and much of the Southeast Area. Consideration of pre-remediation concentrations, however, is appropriate for the purpose of assessing potential contaminant flow pathways for the purpose of proposing soil sample locations.

The concentrations of DDT in the soil were greatest in the surficial soil inside of GP-1. The DDT concentrations in the topsoil in GP-1 ranged from 3.0 micrograms/gram (µg/g) to 73 µg/g. The maximum historic concentration of DDT in soil samples collected outside of GP-1 (1.1 µg/g) was substantially less than the minimum DDT concentration in the soil samples collected from inside of GP-1. The following presents the DDT concentrations in samples collected from within 30 (m).

Location	*Table 8 Standards (Agricultural Uses) (µg/g)*	*Measured DDT Concentration (µg/g)*	*Sample Depth (m bgs)*	*Distance from Site Boundary (m)*
TP07-11	0.078	ND(0.04)	0 – 0.61	15
TP13-11		0.3	0 – 0.15	25
TP14-11		0.09	0.15 – 1.4	25
TP15-11		0.025	0 – 0.40	3
TP16-11		0.012	0.15	15

Location	*Table 8 Standards (Agricultural Uses) (µg/g)*	*Measured DDT Concentration (µg/g)*	*Sample Depth (m bgs)*	*Distance from Site Boundary (m)*
TP18-11		0.37	0 – 0.30	3

There were three samples collected from within 30 m of the Site boundaries in which the measured concentration was greater than the Table 8 Standard. For comparative purposes, the MOECC published background concentration of DDT at industrial facilities in Ontario is 1.4 µg/g[6]. Therefore, the maximum concentration of DDT detected in soil samples collected from outside of GP-1 was less than the MOECC's published background concentration for industrial sites.

Prior to the 2013 and 2014 remediation, the greatest dioxin and furan TEQ concentration at the Site was 81,197 pg/g, in a surficial soil sample collected from a test pit inside the northern portion of GP-1 (TP09-11), which was approximately 75 m from the Site boundary. The dioxin and furan TEQ in a surficial soil sample collected from TP08-11 was 60,913 pg/g while a deeper sample collected from the 1.52 to 1.83 m bgs interval of this same test pit was 1.69 pg/g. This indicates that the dioxin and furan contamination was predominantly in the surficial soil. The shallow nature of the dioxin and furan contamination in the soils is not surprising as dioxins and furans tend to sorb tightly to fine grained soil particles and are not readily soluble in water.

The maximum concentrations of the dioxins and furans were present in and immediately surrounding GP-1. The dioxin and furan TEQs and DDT concentrations in soil samples were generally two to three orders of magnitude greater inside of GP-1 than anywhere else on the east side of the Site. The dioxin and furan TEQs in soil samples collected from within 30 m of the Site boundary (prior to all pre-remediation work) are presented below:

Location	*Table 8 Standards (All Uses) (pg/g)*	*Measured Dioxin/Furan TEQ (pg/g)*	*Sample Depth (m bgs)*	*Distance from Site Boundary (m)*
S-32(02)	7	3.78	0 – 0.15	30
S-5(02)		3,110	0 – 0.15	20
S-6(02)		446	0 – 0.15	15
TP07-11		15.92	0 – 0.61	15
TP13-11		53.21	0 – 0.15	25

6 As described in Table 1 entitled "Full Depth Background Site Condition Standards" of the Ontario Ministry of the Environment (MOE) document entitled *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*, April 2011 (Standards).

Location	*Table 8 Standards (All Uses) (pg/g)*	*Measured Dioxin/Furan TEQ (pg/g)*	*Sample Depth (m bgs)*	*Distance from Site Boundary (m)*
TP14-11		34.61	0.15 – 1.4	25
TP15-11		25.57	0 – 0.40	3
TP16-11		218.59	0.15	15
TP18-11		45.64	0 – 0.30	3

The expectation that liquid wastes would not crest the eastern ridge of GP-1 is supported by the analytical result of S-32(02), which is a soil sample collected in 2002, approximately 20 m east of the northern portion of GP-1 (i.e., east of the most heavily impacted part of GP-1) and TP07-11, which is located approximately 20 m to the northeast of GP-1. The dioxin and furan TEQ in S-32(02) was 3.78 pg/g, which was less than the Table 8 Standard of 7 pg/g. The dioxin and furan TEQ in the sample collected from TP07-11 was 15.92 pg/g, which was slightly greater than the Table 8 Standards[7].

Although CRA collected a subset of soil samples for analysis of VOCs, there have been no surficial soil samples submitted for analysis of chlorophenols, PHC, or VOCs within 30 m of the Site boundary.

To assess the potential for off-Site migration of contamination, CRA will collect three surficial soil samples from the southern Site boundary, south of each of TP15-11, TP-16-11, and TP18-11. The dioxin and furan TEQ at each of these locations was greater than the Table 8 Standard. CRA will also collect two samples to the east of former GP-1 to the east of S-5(02) and S-6(02), where the dioxin and furan TEQ were greater than the Table 8 Standard. As this area of the Site has undergone remediation (in 2013 and 2014), and the most heavily impacted soil has already been removed including the soil as represented by S-5(02) and S-6(02), CRA will collect composite soil samples from the upper 0.15 m of soil within 1 m of the Site boundary. CRA will explicitly ensure that the soil samples are collected from outside of the remediated areas such that samples are collected from native soil and not collected from the previously tested fill material that was placed over this area as a soil cover. Additionally, CRA will submit two of these samples (one collected south of the gravel pits and one to the east) for laboratory analysis of VOCs and PHC. The specific locations will be selected based on evidence of visual and olfactory evidence of impact, and based on field screening with a PID.

[7] Although the property boundary samples in the southeast area will be compared to the Table 8 Standards, TP07-11 was excavated more than 30 from the Creek. Therefore, the dioxin and furan TEQ was only slightly greater than the more applicable Table 2 Standard of 13 pg/g. Furthermore, the dioxin and furan TEQ is less than the Human Risk Criterion, applicable to the Site.

Section 5.0 Shallow Groundwater Quality

5.1 Introduction

Beginning in 1981 a series of shallow monitoring wells were installed along the eastern and southern Site boundaries. Routine groundwater quality monitoring was completed sporadically in the 1980s. In 1990, many of the wells were sampled numerous times in conjunction with the investigation of N-nitrosodimethylamine (NDMA) in Elmira's groundwater. Commencing in 1993 a select group of these wells was included in annual groundwater quality monitoring. In 2008, MOECC and CPAC were consulted and Chemtura's annual groundwater quality monitoring programs were rationalized. Monitoring at some wells ceased and the monitoring frequency at other monitoring wells was reduced. The east and south boundary wells were also sampled during groundwater investigations at the Site, most notably in 2007 and 2011 in conjunction with the an investigation of DNAPL) and the remediation of GP-1 and GP-2, respectively.

The groundwater data collected prior to 1993 were not routinely archived or routinely reported to MOECC (and its predecessors). In 1993, a database of groundwater monitoring data was established. Information collected prior to 1993, some by other stakeholders, was included in the database. There is insufficient information to validate the pre-1993 data. The pre-1993 database may contain erroneous or incorrect results. It may also duplicate some results. NDMA data from prior to 1993 may have been analyzed using methods that do not comply with current standards. For example, detection limits reported for some of the 1990 and 1991 NDMA results could not be achieved by the standard method adopted in 1993.

This section describes the groundwater quality at each of the southern and eastern boundary wells. The shallow wells were selected because they would be the most susceptible to impact from waste materials in the former waste management areas. NDMA and chlorobenzene are discussed because they are the most widespread Chemtura Predecessor derived contaminants and have the most abundant data sets. Other organic parameters are also discussed recognizing that a variety of waste materials were historically present on the east side of the Site. The locations of all groundwater monitoring wells discussed below are shown on Figure 5.1.

5.2 CH-57B

CH-57B is located in the cemetery east of the northeast corner of the Site, east of former waste management area IR-2. The Regional Municipality of Waterloo (RMOW) installed CH-57B in

September 1990. Figure 2.6c (Cross Section D-D') shows CH-57B. The CH-57B well screen extends from 10.7 to 15.2 m bgs and is installed in soils described as "interbedded clay silt, and gravel seams", presumably the UAT. CH-57B is functional and in good repair.

RMOW sampled CH-57B four times. NDMA results were as follows:

CH-57B NDMA Results (µg/L)				
	9/19/1990	***9/28/1990***	***10/12/1990***	***1/14/1991***
CH-57B	0.0016 I	ND(0.015)	0.00179	0.0815
Note: I This qualifier is not defined in the historic Chemtura database.				

The September 19, 1990 and October 12, 1990 NDMA concentrations are suspect because they are less than current detection limit of 0.002 micrograms per litre (µg/L). The January 14, 1991 sample (only) was also analyzed for a long list of VOC, SVOC, metals, and general chemistry compounds. For the organic compounds only trace concentrations of a few SVOCs were detected.

With respect to evaluating the potential for groundwater contaminant migration across the eastern Site boundary, the fact that CH-57B has not been sampled since 1991 represents a data gap. CRA recommends Chemtura collect a groundwater sample from CH-57B and analyze it for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If elevated concentrations of chlorophenols, 2,4-D, or 2,4,5-T are identified in the groundwater sample (i.e., concentrations greater than ODWS), CRA will recommend that a sample also be collected and submitted for analysis of dioxins and furans. Chlorophenols, 2,4-D, and 2,4,5-T are good indicators of the potential presence of dioxins and furans in the groundwater as the dioxins and furans were byproducts of the 2,4-D and 2,4,5-T production processes.

5.3 OW7-3 and OW7-6

Monitoring wells OW7-3 and OW7-6 were installed along the eastern Site boundary in May 1984 east of RPE-1. The OW7-3 well screen extends from approximately 1.5 to 3.0 m bgs and was installed in "medium to fine sand" corresponding to the SA, as shown on Figure 2.6c (Cross Section D-D'). The OW7-6 well screen extends from approximately 5 to 6 m bgs in soil described as silt, clayey, minor sand lenses. This corresponds to the UAT. Both wells are still functional.

Wells OW7-3 and OW7-6 have been sampled three and five times, respectively and NDMA results are as follows:

Well	NDMA Concentration (µg/L)					
	1/19/1990	*10/2/1990*	*10/19/1990*	*7/26/1994*	*12/5/1994*	*11/14/1996*
OW7-3	Not Sampled	0.168	0.016	NS	NS	0.013
OW7-6	6.8	9.83	6.8	1.11	1.36	Not Sampled

The NDMA concentration in the groundwater sample collected from OW7-3 in 1996 was slightly greater than the Ontario Drinking Water Quality Standards (ODWS) for NDMA (0.009 µg/L). CRA collected the sample from OW7-3 in 1996 in conjunction with the investigation of the DNAPL occurrence near SA monitoring well OW148-3. This sample was analyzed for VOCs and SVOCs and except for NDMA, no organic compounds were detected. This is consistent with the west to southwest groundwater flow direction in the SA that prevents eastward groundwater contamination migration.

The concentration of NDMA in samples from OW7-6 has decreased over time but was still much greater than the ODWS the last time OW7-6 was sampled. The groundwater samples collected from OW7-6 in 1994 were analyzed for VOCs and SVOCs. Other than NDMA and related nitrosamine species, 2,4-dichlorophenol and 2,6-dichlorophenol were the only other organic compounds detected, at concentrations of 4.7 and 5.3 µg/L, respectively. For comparative purposes, the Table 2 Standards for 2,4-dichlorophenol is 20 µg/L.

With respect to evaluating the potential for groundwater contamination migration across the eastern Site boundary, the fact that OW7-3 and OW7-6 have not been sampled since 1994 and 1996 represents a data gap. CRA recommends Chemtura collect a groundwater sample from OW7-3 and OW7-6 and analyze them for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If elevated concentrations of chlorophenols, 2,4-D, or 2,4,5-T are identified in groundwater samples (i.e., concentrations greater than ODWS), CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.

5.4 OW7s

Monitoring well OW7s was installed in a layer of brown, poorly graded fine sand that corresponds to the SA. OW7s is located immediately southeast of former waste management unit RPE-3, as shown on Figure 5.1. SA groundwater flows west to southwest, which means OW7s is located upgradient of the former waste management areas. The well is functional.

Eighteen samples were collected from OW7s from 1981 through 1989 and again in 2007. The samples were analyzed for variety of parameters, but not NDMA. Organic compounds were detected only rarely and at low concentrations. Chemtura sampled OW7s in 2007 and analyzed the sample for VOCs. None were detected.

Given that OW7s is upgradient of the former RPW4 and RPE5 waste management areas and there is no indication of significant groundwater contamination in the groundwater quality data, there is a very low potential that eastward contaminant migration occurred in groundwater at this location. However, Figure 5.1 shows that OW7s is located approximately 150 m south of the other OW7 monitoring wells and there are no monitoring wells in between. CRA recommends Chemtura install two temporary monitoring wells to assess groundwater quality. Figure 5.2 shows the location of the proposed temporary monitoring wells. One temporary well will be installed east of RPE-2 and the second will be installed east of RPE-3, near the Site boundary. CRA recommends Chemtura collect a groundwater sample from these two temporary monitoring wells and analyze them for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans. CRA will evaluate these data to determine if permanent monitoring wells are warranted at these locations.

5.5 OW39-4, OW39-6, and OW39-9

Figure 2.6c (Cross Section D-D') shows wells OW39-4, OW39-6, and OW39-9 installed in May 1984 in a sequence of silt and clay in the UAT. Sand lenses were present within the clay at a depth of approximately 4 to 9 m below ground surface. OW39-4 was installed in 1986. There is no SA or UA_1 present at this location. The OW39 well nest is immediately east of (or in the northeast corner of) former waste management area RPE-3, as shown on Figure 5.1. All three wells have been destroyed.

The Chemtura database does not contain any record of groundwater elevation measurements or groundwater samples being collected from these wells.

5.6 OW26-9

Figure 2.6b (Cross Section D-D') shows monitoring well OW26-9 installed in a sequence of silty sand and poorly graded sand southeast of former waste management unit RPE-3. OW26-9 is a UAT monitoring well. The well is functional but has only been sampled once. Chemtura sampled OW26-9 in 2007 and analyzed the sampled for VOCs. None were detected.

With respect to evaluating the potential for groundwater contamination migration across the eastern Site boundary the fact that OW26-9 only been sampled once and only VOC results are available represents a data gap. CRA recommends Chemtura collect a groundwater sample from OW26-9 and analyze it for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.

5.7 OW28-2, OW28-5, and OW28-6

OW28-2 was installed in 1985 and according to the well status database it was abandoned. CRA does not have a stratigraphic log for this well. OW28-5 was installed in 1988 but CRA does not have a stratigraphic log for the well. OW28-5 remains a functional well. OW28-6 was installed in 1984. It was subsequently destroyed. OW28-6 was installed in brown silt with sand lenses overlying grey clay.

There is no record of OW28-2 having been sampled. OW28-5 was sampled eight times in 1998 through 1990 and again in 2007. Chlorobenzene was detected once (3.7 μg/L in 1990) as was toluene (2.2 μg/L in 1988), but not in subsequent samples. The sample collected in November 1990 was analyzed for NDMA and it was detected at a concentration of 10.3 μg/L. OW28-6 was sampled thirteen times in 1981 through 1991. Chlorobenzene was not detected. Other VOCs were only detected rarely, and at low concentrations. Three of these samples were analyzed for NDMA (1990 and 1991) and it was detected in all three samples at concentrations that ranged from 9.6 to 35.1 μg/L.

The lack of groundwater quality data, other than VOCs, represents a data gap with respect to evaluating the potential for groundwater contaminant migration across the eastern Site boundary. Historic NDMA concentrations were much greater than the ODWS of 0.009 μg/L. CRA recommends Chemtura collect a groundwater sample from OW28-5 and analyze it for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.

5.8 OW32-3, OW32-6, and OW32-8

Monitoring well OW32-6 was installed in May 1984 and monitoring wells OW32-3 and OW32-8 in June 1988. The OW32 monitoring well nest is located in the north end of former waste management area RB-1 and east of RPE-5, which was still present at the time the wells were installed. As shown on Figure 2.6b (Cross Section D-D'), OW32-3 was installed in a layer of brown silty sand. Figure 2.4 (Cross Section B-B') shows that this shallow sand layer is not

contiguous with the UA_1 to the west. OW32-6 and OW32-8 were installed in the clay and silt underlying the UA_1. There is a silty sand lens near the top of the OW32-8 well screen. OW32-6 was abandoned but OW32-3 and OW32-8 remain functional wells.

OW32-3 has been included in routine groundwater monitoring since 1996. No organic compounds were detected in the latest sample, collected in 2013. OW32-6 was sampled five times from 1984 through 1986 for VOCs, pesticides and general chemistry parameters. Total phenols in these samples ranged from 280,000 μg/L to 320,000 μg/L. 2,4-D and 2,4,5-T were detected in a sample collected in 1986 at concentration of 27,000 and 930 μg/L, respectively. OW32-8 replaced OW32-6, which has been decommissioned, and Chemtura sampled OW32-8 routinely since 1994 for VOCs, SVOCs and pesticides. Chlorobenzene has never been detected. NDMA was detected at a concentration of 0.016 μg/L in 1994 but has not been detected since. Other organic compounds were detected very rarely and at low concentrations.

The lack of contaminants in samples collected from OW32-3 and OW32-8 during routine groundwater quality monitoring indicates there is no potential for the eastward off-Site migration of groundwater contaminants in this area.

5.9 OW34-5

Monitoring well OW34-5 was installed in May 1984. Figure 5.1 shows OW34-5 was located along the western limit of former waste management area RB-2 and immediately east of RPE-5, which was still present at the time the well was installed. As shown on Figure 2.6b, (Cross Section D-D'), OW34-5 was installed in brown silty sand and the grey clay beneath it. This sand layer is not contiguous with the UA_1 to the west and to the south. There is no record of well OW34-5 being sampled and the well has been abandoned.

5.10 OW36-5

Monitoring well OW36-5 was installed in May 1984. Figure 5.1 shows OW34-5 was located along the western limit of former waste management area RB-2 and immediately east of RPE-5. Figure 2.6b (Cross section D-D') shows the OW36-5 well screen straddles a thin layer of brown sand. OW36-5 was abandoned in 1993.

Six samples were collected from OW36-5 between 1984 and 1992. The samples were analyzed for variety of parameter, but not chlorobenzene. NDMA was analyzed in the sample collected in 1992 at a concentration of 0.013 μg/L. Benzene was detected at concentrations that ranged from 20,000 to 33,600 μg/L. Concentrations of 2,4,5-T ranged from 76 to 2,800 μg/L.

The lack of recent groundwater quality data from the well installed in the shallow sand to the area east of former waste management unit RPE-5 represents a data gap with respect to evaluating the potential for groundwater contaminant migration across the eastern Site boundary. CRA recommends Chemtura install a temporary monitoring well in the shallow sand near the location of former monitoring well OW36-5 and collect a groundwater sample from it for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides analyses. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans. CRA will evaluate the results from these groundwater samples to determine if a permanent monitoring well is warranted at this location.

5.11 OW38-5 and OW38-6

Monitoring well OW38-5 was installed in May 1984. CRA does not have a stratigraphic log for this well. OW38-6 was installed in 1988, presumably after abandoning OW38-5. Figure 5.1 shows OW38-6 is located within the footprint of the former waste management area RB-2 and at the southeast corner of RPE-5. Figure 2.6b, (Cross Section D-D') shows OW38-6 was installed in a grey silty clay beneath a thin sand layer.

Five samples were collected from OW38-5 from 1984 through 1986. The samples were analyzed for variety of parameters, but not NDMA or chlorobenzene. Benzene was detected in two samples at concentrations of 1,100 and 1,700 μg/L. Pesticide compounds were also detected, with concentrations of 2,4-D and 2,4,5-T ranging from 320 to 6,200 μg/L and 39 to 3,300 μg/L, respectively. OW38-6 was sampled seven times from 1988 through 1991 and again in 2007. The 2007 sample was analyzed for VOCs only and none were detected.

The difference in contaminant concentrations between OW38-5 and OW38-6 may be the result of the different screen placements for the well. OW38-6 has a well screen entirely in the clay underlying the sand layer. The OW38-5 well screen was installed at a slightly higher elevation and extended up into the sand layer. Therefore, contamination present in the sand layer would be detected in samples from OW38-5 but not in samples from OW38-6.

The lack of recent groundwater quality data from the well installed in the shallow sand to the area east of former waste management unit RPE-5 represents a data gap with respect to evaluating the potential for groundwater contamination migration across the eastern Site boundary. CRA recommends Chemtura install a temporary monitoring well in the shallow sand near the location of former monitoring well OW38-5 and collect a groundwater sample from it for NDMA, VOCs, SVOCs, chlorinated herbicides and OC pesticides analyses. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in the groundwater sample, CRA

will recommend that a sample also be collected and submitted for analysis of dioxins and furans.

5.12 OW8s and OW8-4

Figure 2.6b, (Cross Section D-D') shows monitoring wells OW8s and OW8-4 are installed in a sequence of silty sand and poorly graded sand. Figure 5.1 shows OW8-4 located immediately south of former waste management unit BAE-1. OW8s is located near the southern end of former waste management area BAE-1 and southeast of RPE-5, before RPE-5 was covered and then eventually remediated. OW8s and OW8-4 were installed in 1981 and 1986, respectively. Both wells remain functioning monitoring wells.

OW8s has never been included in routine groundwater quality monitoring. OW8s was sampled eleven times from 1984 through 1991. Chlorobenzene was detected once, at a concentration of 1.17 μg/L. Only one of these samples, collected in October 1990, was analyzed for NDMA. NDMA was detected at a concentration of 0.13 μg/L. OW8s was also sampled in 2007. The sample was analyzed for VOCs only and none were detected.

OW8-4 was included in routine annual groundwater quality monitoring from 1995 through 2006. NDMA was not detected (RDL = 0.01 – 0.06 μg/L) in any of these routine samples. Chlorobenzene was detected once in 17 routine samples (0.6 μg/L, July 3, 2001) collected since 1995. Other organic compounds were analyzed for in these samples, primarily VOCs and pesticides. Benzene and 2,6-dichlorophenol were detected routinely. Benzene concentrations ranged from ND(0.5) to 22 μg/L. 2,6-Dichlorophenol concentrations ranged from ND(1.2) to 14 μg/L. Other organic compounds were only rarely detected in groundwater samples collected from OW8-4. Routine groundwater sampling ceased in 2006 when the routine groundwater monitoring programs were rationalized. OW8-4 was not included in the revised monitoring program because of the lack of contaminants in the groundwater.

The lack of post-2006 groundwater quality data from samples collected from OW8s and OW8-4 do not represent a data gap with respect to evaluating the potential for groundwater contamination migration across the eastern Site boundary. There was over a decade of routine groundwater quality monitoring for a variety of parameters following remediation of RPE-4 and RPE-5.

5.13 OW14s

Monitoring well OW14s was installed in July 1981, in a swampy area south of RPE-5 and northeast of GP-1. As shown on Figure 2.6a, (Cross Section D-D'), OW14s was installed in the brown poorly graded sand/gravel/silt of the UA_1 in close proximity to GP-1 and GP-2.

OW14s was sampled seven times from 1982 through 1985 and chlorobenzene was detected twice at a concentration of 2 μg/L. OW14s was sampled five times in 1990. Chlorobenzene was not detected. Two of these samples were analyzed for NDMA and it was detected in one sample at a concentration of 0.01 μg/L. Numerous organic compounds were also analyzed for in these samples with only rare detections. For example toluene was detected in a sample collected in June 1985 at a concentration of 30 μg/L but it was not detected in any of the 10 samples collected since. OW14s has not been sampled since 1990.

The lack of recent groundwater quality data from monitoring well OW14s represents a data gap. However, with respect to evaluating the potential for groundwater contamination migration across the eastern Site boundary OW14s is located too far from the Site boundary to provide information with respect the eastward migration of groundwater contamination across the Site boundary.

5.14 OW15-4 and OW15s

Monitoring well OW15s was installed in the southeast corner of the Site in July 1981, in close proximity to GP-1 and GP-2. As shown on Figure 2.6a, (Cross Section D-D'), the OW15s well screen was installed in grey well-graded sand with fine to medium-grained gravel of the UA_1. In November 1995, OW15s was abandoned and replaced with a new monitoring well OW15-4, screened across a similar interval.

OW15s was sampled sixteen times from 1981 through 1995. Chlorobenzene was detected intermittently, at a maximum concentration of 11.8 μg/L, much less than the ODWS of 80 μg/L. Four groundwater samples collected in 1990 and 1992 had NDMA at concentrations that ranged from 0.36 to 0.053 μg/L. Subsequent annual groundwater samples from 1993 through 1995 did not contain NDMA (RDL = 0.01 μg/L). In 1996, OW15-4 replaced OW15s in the routine groundwater quality-monitoring program. Chlorobenzene was detected intermittently, at a maximum concentration 2.8 μg/L and NDMA has never been detected (RDL = 0.01 μg/L) in groundwater samples collected from OW15-4.

In August 2011, groundwater samples from OW15-4 were collected and submitted for analysis of herbicides and pesticides (including DDT) and dioxins and furans. No pesticides or herbicides were detected. Similarly, no dioxins or furans were detected and the TEQ was calculated as 0 μg/L.

Chemtura completed remediation of the former GP-1 and GP-2 in 2013 and 2014. As impacted soil remained in place following remediation, CRA recommends additional groundwater characterization to confirm that these residual contaminants are not migrating horizontally or

vertically through the groundwater. CRA recommends Chemtura collect a groundwater sample from OW15-4 and analyze the sample for NDMA, VOC, SVOC, dioxins, furans, chlorinated herbicides and OC pesticides.

5.15 OW146-3

Monitoring well OW146-3 was installed in the southeast corner of the Site in November 1995, approximately 40 m west of the OW15 monitoring well nest. GP-2 is located to the north of OW146-3 as shown on Figure 5.1. OW146-3 was installed in brown sand and gravel with black staining and a strong odour. This corresponds to the UA_1.

Annual groundwater samples were collected from OW146-3 from 1995 through 1996. Chlorobenzene was detected intermittently, at a maximum concentration 3.4 μg/L, much less than the ODWS of 80 μg/L. NDMA has never been detected (RDL = 0.01 μg/L) in groundwater samples collected from OW146-3.

In August 2011, groundwater samples were collected from OW146-3 and submitted for analysis of herbicides and pesticides (including DDT) and dioxins and furans. No pesticides or herbicides were detected. Pentachlorodibenzofuran was the only dioxin or furan detected, at a concentration of 0.00588 J[8] μg/L and the TEQ was calculated as 0 μg/L.

Chemtura completed remediation of the former GP-1 and GP-2 in 2013 and 2014. As impacted soil remained in place following remediation, CRA recommends that Chemtura collect a groundwater sample from OW146-3. CRA recommends this sample be analyzed for NDMA, VOC, SVOC, dioxins, furans, chlorinated herbicides and OC pesticides.

5.16 OW99-3

Monitoring well OW99-3 was installed adjacent the southern Site boundary in November 1995. GP-2 is located to the north of OW99-3 as shown on Figure 5.1. OW99-3 was installed in grey sand and gravel that corresponds to the UA_1.

Four groundwater samples were collected from OW99-3 from 1993 through 1995. Chlorobenzene was detected in three of the four samples at a maximum concentration of 24 μg/L, less than the ODWS of 80 μg/L. NDMA was detected in the initial 1993 sample collected from OW99-3 at a concentration of 0.128 μg/L but it was not detected (RDL = 0.01 or 0.002 μg/L) in subsequent groundwater samples collected from OW99-3.

[8] J- The parameter was positively identified; however, the associated parameter concentration is estimated.

In August 2011, groundwater samples were collected from OW99-3 and submitted the samples for analysis of herbicides and pesticides (including DDT) and dioxins and furans. No pesticides or herbicides were detected. Similarly, no dioxins or furans were detected and the TEQ was calculated as 0 μg/L.

Chemtura completed remediation of the former GP-1 and GP-2 in 2013 and 2014. As impacted soil remained in place following remediation, CRA recommends additional groundwater characterization to confirm that these residual contaminants are not migrating horizontally or vertically through the groundwater. CRA recommends Chemtura collect a groundwater sample from UA_1 monitoring well OW99-3 and analyze the sample for NDMA, VOC, SVOC, dioxins, furans, chlorinated herbicides and OC pesticides.

5.17 OW145-4

Monitoring well OW145-4 was installed adjacent to the southern Site boundary and south of GP-2 in November 1995. OW145-4 was installed in grey sand and gravel with a strong chemical odour. This corresponds to the UA_1.

Annual groundwater samples were collected from OW145-4 from 1995 through 1996. Chlorobenzene was detected at a concentration of 87 μg/L, slightly greater than the ODWS of 80 μg/L. In subsequent samples chlorobenzene concentrations decreased to 15 μg/L in 2006. Similarly, NDMA concentrations in groundwater samples collected from OW145-4 decreased from 5.11 μg/L in 1995 to less than the RDL (0.01 μg/L) in 2006.

In August 2011, groundwater samples were collected from OW146-3 and submitted for analysis of herbicides and pesticides (including DDT) and dioxins and furans. No pesticides or herbicides were detected. No dioxins or furan were detected and the TEQ was calculated as 0 μg/L.

Chemtura completed remediation of the former GP-1 and GP-2 in 2013 and 2014. As impacted soil remained in place following remediation, CRA recommends Chemtura collect a groundwater sample from OW145-4. CRA recommends this sample be analyzed for NDMA, VOC, SVOC, dioxins, furans, chlorinated herbicides and OC pesticides.

5.18 OW16-3 and OW16s

Monitoring well OW16s was installed along the southern Site boundary and adjacent Canagagigue Creek in July 1981 southwest of GP-2. The OW16s well screen was installed in grey sand and gravel of the UA_1. In November 1995, OW16s was abandoned and replaced with new monitoring well OW16-3.

OW16s was sampled numerous times from 1982 through 1995. Chlorobenzene was detected at concentrations that range from ND(0.5) to 81 μg/L, occasionally greater than the ODWS of 80 μg/L. Chemtura collected subsequent annual groundwater samples from OW16-3 from 1995 through 2008. Between 1995 and 1998, chlorobenzene concentrations decreased from 70 to 4.1 μg/L. Groundwater samples collected from OW16s in 1990 through 1995 contained NDMA at concentrations that ranged from 0.34 to 9.35 μg/L. In 1995, samples were collected annually from OW16-3 and NDMA concentrations decreased from 0.098 μg/L to non-detect (RDL = 0.01 μg/L) in 1999 and remained non-detect through 2008 when routine sampling of OW16-3 ceased.

In August 2011, in conjunction with the GP-1 and GP-2 investigation, groundwater samples from OW16-3 were collected and submitted for analysis of herbicides and pesticides (including DDT) and dioxins and furans. No pesticides or herbicides were detected. Similarly, no dioxins or furans were detected and the TEQ was calculated as 0 μg/L. CRA recommends Chemtura collect a groundwater sample from OW16-3. CRA recommends this sample be analyzed for NDMA, VOC, SVOC, dioxins, furans, chlorinated herbicides and OC pesticides.

Section 6.0 Summary and Conclusions

The hydrogeology beneath the Elmira area and beneath most of the Site is dominated by thick sequences of sand and gravel alluvial deposits that correspond to prolific aquifers. Beneath the northeast portion of the Site, where the ground surface reaches an elevation of 350 m or greater, the prolific aquifers are either very thin or entirely absent and the stratigraphic sequence is dominated by fine grained silt or clay tills with only occasional sand lenses present. The UA and the MU are not present beneath the northeast corner of the Site and the ML is present as a thin (~1 m thick) sand layer. The perched SA is located in the northeast corner of the Site. SA groundwater flows west, away from the eastern Site boundary.

Starting in the 1940s Chemtura's predecessors operated a series of waste management units on the east side of the Site. By 1970, most of the waste material had been consolidated into RPE-4 and RPE-5. In 1994, RPE-4 and RPE-5 were excavated and the excavated wastes stored in an on Site containment facility (Building 60) located on the northeastern portion of the Site. In 1999, the wastes were removed from the containment facility and disposed at a secure off-Site landfill. In 2009, Chemtura excavated and disposed of approximately 565 tonnes of commingled fill and waste from RPE-3 that were discovered during an earlier investigation of east side contamination. In 2013 and 2014, Chemtura completed remediation work near GP-1 and GP-2 to reduce the quantity of soil impacted with DDT, dioxins and furans and to reduce the potential exposure risks to human and ecological receptors. During this time, Chemtura

excavated the most heavily impacted soil from GP-1, and disposed of the soil off Site as non-hazardous waste material. Chemtura also imported clean topsoil to use as backfill and to use as a soil cover in GP-1, GP-2, and the southeast area.

Based on the topography of the east side of the Site, liquid overflow from the former waste pits was historically directed towards the GP-1 area of the Site. Although Chemtura and Chemtura's Predecessors have investigated the east side of the Site and remediated priority areas, there are data gaps along the eastern Site boundary. Although the risk of exposure to impacted soil is less on-Site than off-Site, the receptors on the neighbouring property to the east are more sensitive (i.e., residential and agricultural), and requires more conservative assumptions to be applied. The concentrations of DDT and dioxin and furan TEQs have been investigated previously within 30 to 50 m of the Site boundary. The results of samples collected near the Site boundary indicate that there is soil close to the Site boundary where concentrations are greater than the applicable Table 2 or Table 8 Standards. Furthermore, the concentrations of other potentially applicable contaminants, including chlorophenols, PHC, and VOCs have not been investigated near the Site boundary. Therefore, although the risk of contaminants historically migrating to the neighbouring property is low, the high sensitivity of land use on the neighbouring property (i.e., residential and agricultural) warrants further investigation on the Site boundary.

CRA compiled groundwater quality data from 21 existing and former shallow monitoring wells located along the southern and eastern Site boundaries. Some of these monitoring wells have been included in routine monitoring programs for years after the remediation of RPE-4 and RPE-5. Others were sampled in 2007 for DNAPL related parameters and in 2013 for dioxins and furans with none of these compounds detected. CRA identified data gaps where several existing wells had not been sampled since the remediation of RPE-4 and RPE-5 and near monitoring wells that were abandoned prior to the remediation of RPE-4 and RPE-5 and the potential for groundwater contamination exists.

Section 7.0 Recommendations

The following includes a summary of CRA's recommendations for additional investigation to address the known data gaps.

7.1 Surficial Soil

CRA has proposed 20 surficial soil samples along or near the Site boundary. Based on the historic operations on the east side, CRA has conceptually divided this investigation into three primary areas, including: (1) Former Waste Pit Area, (2) Wetland Area South of RPE-5, and

(3) GP-1, GP-2, and Southeast Area. The following paragraphs summarize CRA's recommendations for sampling in each of these three areas.

To investigate the Site boundary to the east of the former waste pits, CRA will collect nine surficial soil samples from the Site boundary area. CRA will focus the soil sample locations towards areas with the highest potential of impact. This includes:

- Five soil sample locations east of RB-1, RB-2, and BAE-1, which were located on the Site boundary
- One soil sample from immediately east of IR-2, near where S-20(02) was collected
- Three soil samples from locations to the east of the former RPE-1, 2, 3, and 4 waste pits

To investigate the Site boundary in the wetland area south of the former waste pits, CRA will collect six surficial soil samples from this area. These samples will include:

- Three soil samples from locations spaced evenly (approximately one sample per 30 m) along the eastern Site boundary
- Three soil samples from low lying areas (on-Site) between the approximate northern edge of the drainage ditch on the neighbouring property to the east and the former furrows

To investigate the Site boundary in the vicinity of GP-1, GP-2, and the southeast area as a whole, CRA will collect five additional soil samples from this area. These samples will include:

- Three surficial soil samples from the southern Site boundary, south of each of TP15-11, TP-16-11, and TP18-11
- Two samples to the east of former GP-1 to the east of S-5(02) and S-6(02)

CRA will collect composite soil samples from the upper 0.15 m of soil within 1 m of the Site boundary (with the exception of three samples collected near the furrows in the wetland area). CRA will submit the soil samples for analysis of dioxins, furans, chlorophenols, and OC pesticides. CRA will also submit a subset of these samples from each of these three areas (six in total) for laboratory analysis of VOCs and PHC. These locations will be selected based on evidence of visual and olfactory evidence of impact, and based on field screening with a PID.

A summary of the proposed surficial soil sampling locations is provided in Table 7.1.

7.2 Groundwater

Monitoring well OW8-4 was included in routine groundwater quality monitoring programs until 2006. It was removed from the routine groundwater quality monitoring programs because of a persistent lack of detections of contamination. Chemtura continues routine sampling of monitoring well OW32-3 and there is no indication that the former waste management units have affected groundwater quality near this well.

Chemtura sampled existing monitoring wells OW7s, OW8s, OW28-5, and OW38-6 in 2007 in conjunction with a DNAPL investigation. The samples were analyzed for VOCs and none were detected. This lack of contamination in samples collected from these wells approximately 13 years after RPE-4 and RPE-5 were remediated indicates the potential for groundwater contamination to migrate off-Site in the vicinity of these wells is very low.

Chemtura sampled existing monitoring wells OW15-4, OW16-3, OW99-3, OW145-4, and OW146-3 in 2013 conjunction with the investigation of GP-1 and GP-2. The samples were analyzed for pesticides and dioxins and furans and none were detected. This lack of contamination in samples collected from these indicates the potential for groundwater contaminant to migrate off-Site near these wells is very low.

Monitoring wells OW15s and OW16s were abandoned and replaced with monitoring wells OW15-4 and OW16-3, therefore no data gap exists with respect to these wells. Similarly, monitoring wells OW34-5 and OW39s were abandoned but groundwater quality from nearby existing monitoring wells suggest the potential for groundwater contamination at the location of these former monitoring wells is low.

Monitoring wells OW36-5 and OW38-5 were abandoned in 1992 and 1986, respectively. Both wells were located near the southeast corner of RPE-5. NDMA and chlorobenzene data are not available for these wells. Groundwater samples collected from these wells had high concentrations of 2,4,5-T, benzene, and other groundwater contaminants. This represents a data gap with respect to the potential off-Site migration of groundwater contaminants. CRA recommends Chemtura address this data gap by installing temporary monitoring wells (using direct push drilling techniques) near the location of former monitoring wells OW36-5 and OW38-5. These groundwater samples should be analyzed for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If elevated concentrations of chlorophenols, 2,4-D, or 2,4,5-T are identified in groundwater samples (i.e., concentrations greater than ODWS), CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.

Monitoring wells CH-57B, OW7-3, OW7-6, OW26-9 and OW28-5 are located along the eastern Site boundary. Groundwater samples from OW26-9 have never been analyzed for NDMA. A

1990 groundwater sample from OW28-5 contained NDMA at a concentration of 10.3 μg/L. It was subsequently sampled in 2007 but the samples were analyzed for VOCs only (none were detected). CRA recommends Chemtura address this data gap by collecting groundwater samples from OW26-9 and OW28-5 for NDMA analysis. Monitoring wells CH-57B, OW7-3, and OW7-6 have not been sampled since at least 1996 and historic results indicate the presence of NDMA and other groundwater contaminants. CRA recommends Chemtura address this data gap by collecting groundwater samples from monitoring wells CH-57B, OW7-3, and OW7-6. These groundwater samples should be analyzed for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.

OW7s is located approximately 150 m south of the other OW7 monitoring wells and there are no monitoring wells in between. This represents a data gap with respect to shallow groundwater quality east of former waste management units RPE-2 and RPE-3. CRA recommends Chemtura address this data gap by installing temporary monitoring wells between monitoring well OW7s and the rest of the OW7 monitoring wells. These groundwater samples should be analyzed for NDMA, VOCs, SVOCs, chlorinated herbicides, and OC pesticides. If concentrations of chlorophenols, 2,4-D, or 2,4,5-T are greater than the ODWS in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans. A summary of the proposed groundwater sampling recommendations is provided in Table 7.2.

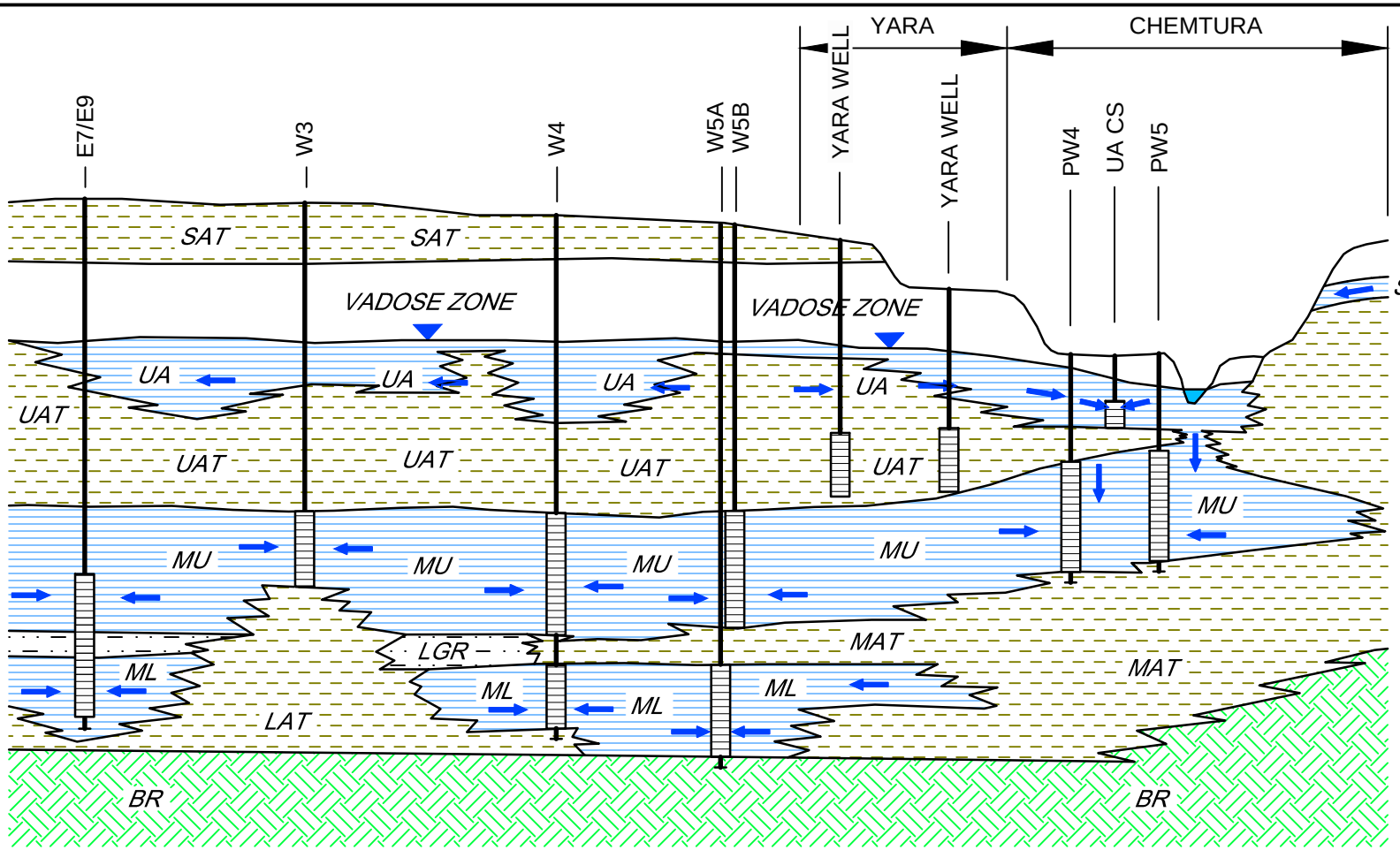
Implementation of the recommendations in this Work Plan are proposed to commence upon approval by MOECC, and suitable (non-winter) weather conditions.

All of Which is Respectfully Submitted,
CONESTOGA-ROVERS & ASSOCIATES

Alan Deal, P. Geo.

Douglas Smith, P. Geo.

Adam Loney, P. Eng.



HYDROGEOLOGICAL UNIT

SA	SURFICIAL AQUIFER	MAT	MUNICIPAL AQUITARD
SAT	SURFICIAL AQUITARD	LGR	LOW GAMMA-RESISTIVITY ZONE
UA	UPPER AQUIFER	ML	LOWER MUNICIPAL AQUIFER
UAT	UPPER AQUITARD	LAT	LOWER AQUITARD
MU	MUNICIPAL AQUIFER	BR	BEDROCK AQUIFER

LEGEND

WELL SCREEN

GROUNDWATER FLOW DIRECTION

figure 2.1

SCHEMATIC CONCEPTUAL HYDROGEOLOGIC MODEL
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA003 JAN 27/2015

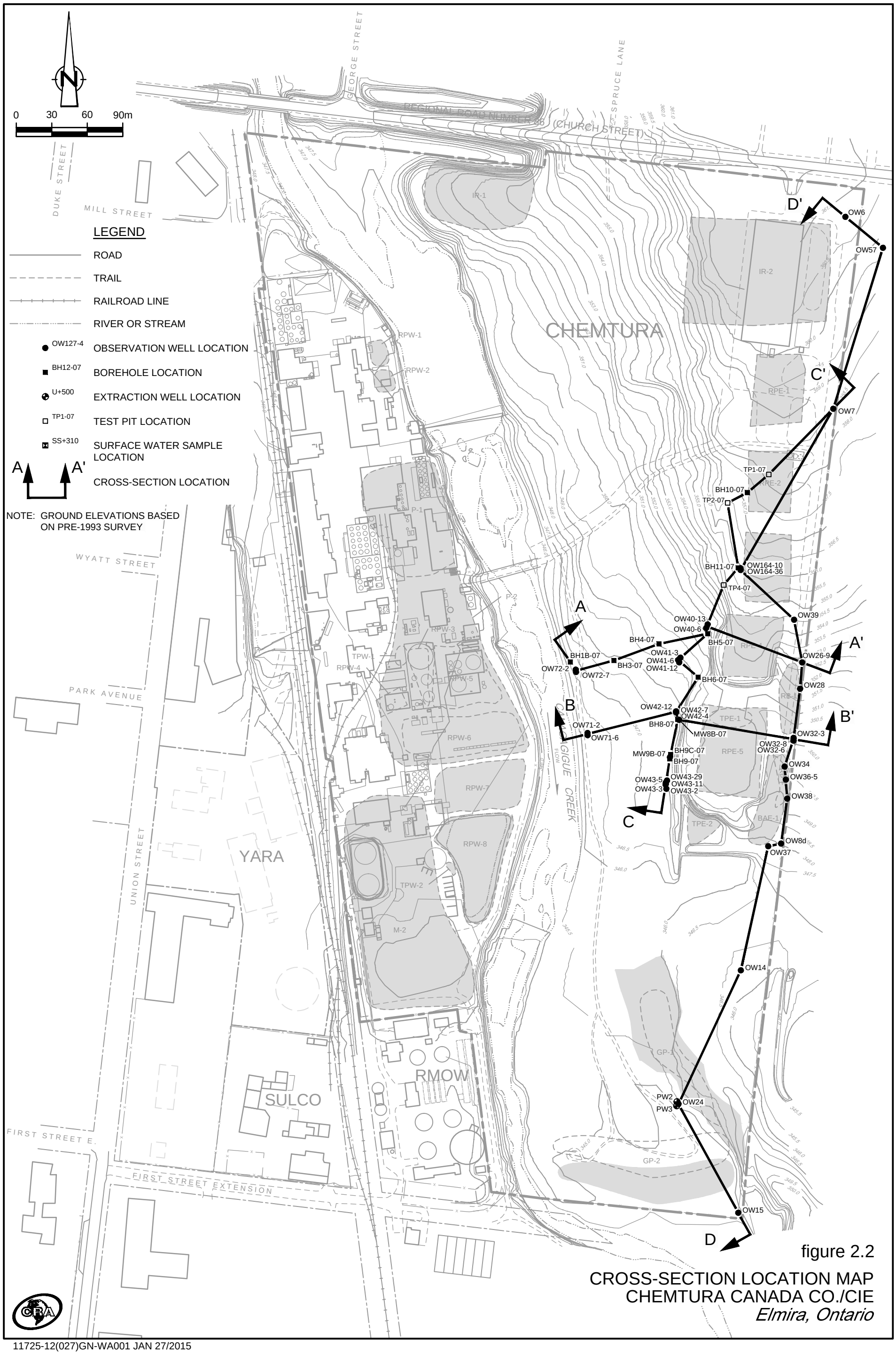
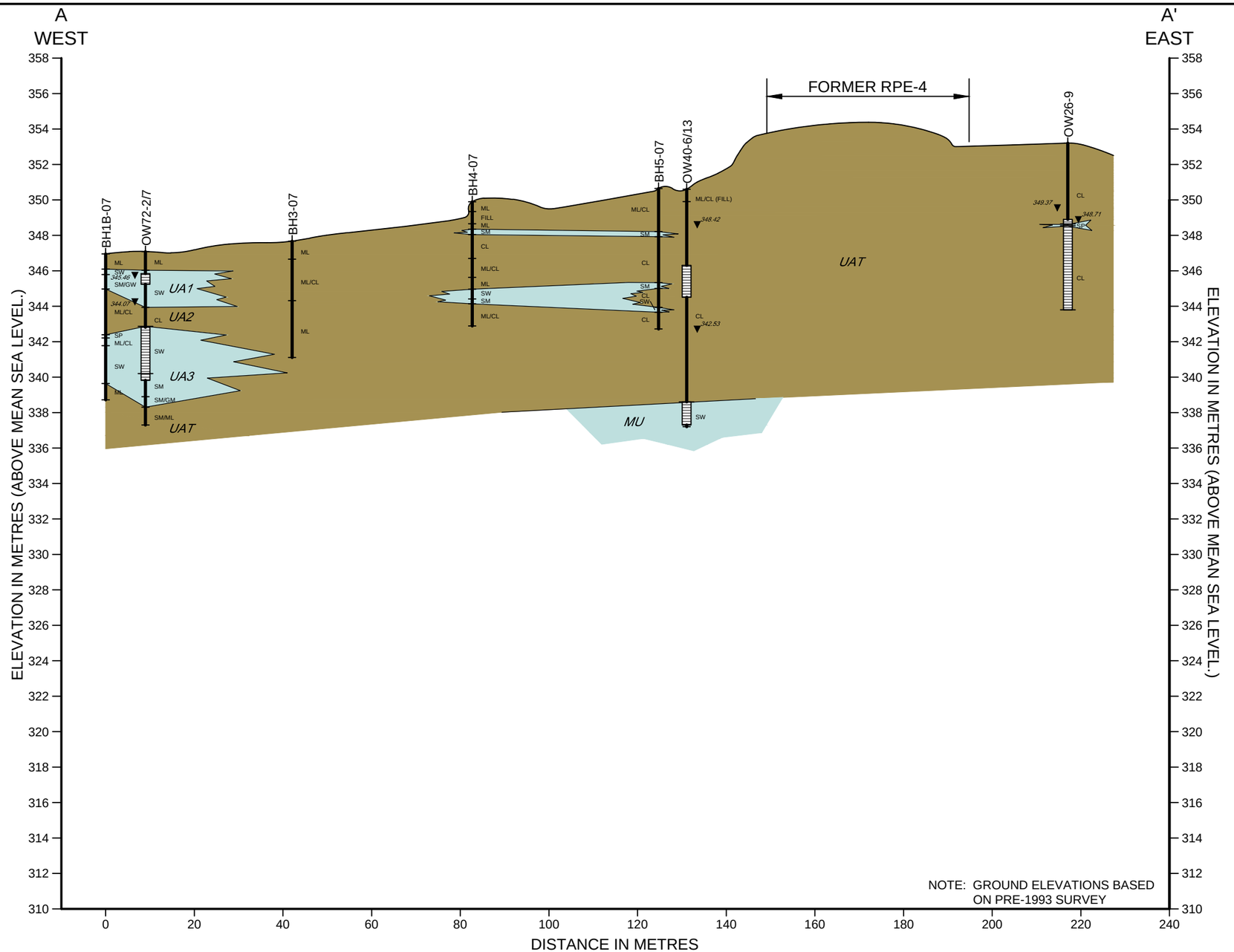


figure 2.2

CROSS-SECTION LOCATION MAP
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA001 JAN 27/2015



SCALE: H: 1:1000
V: 1:250

LEGEND

WELL SCREEN

▼348.79 GROUNDWATER ELEVATION (SEPTEMBER 9, 2014)

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL

SILT, CLAYEY SILT OR SILTY CLAY

SHALE

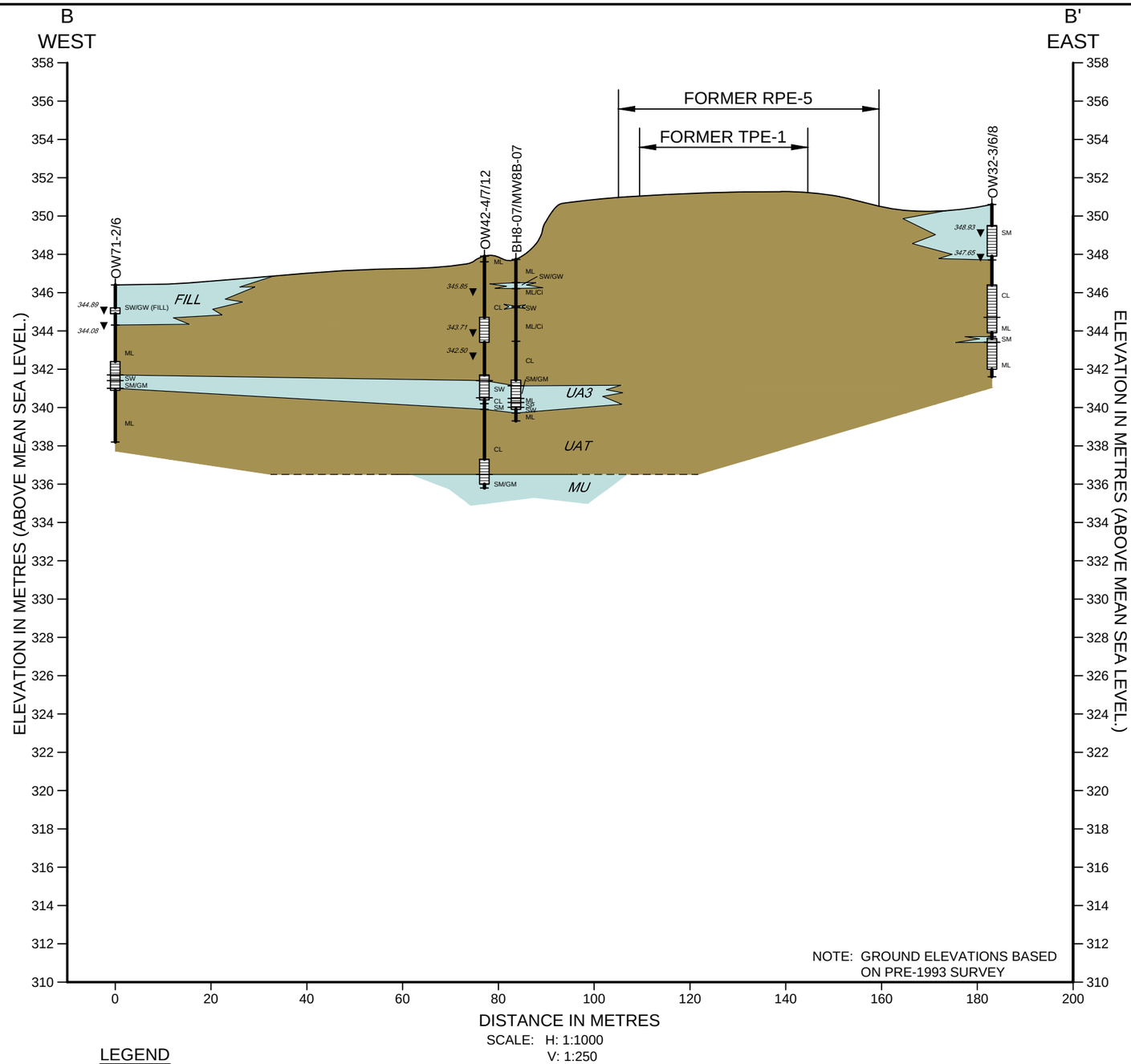
FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

MODIFIED UNIFIED SOIL CLASSIFICATION

CL	=	CLAY
CI	=	SILTY CLAY
ML	=	SILT
SM	=	SILTY SAND
SP	=	POORLY GRADED SAND
SW	=	WELL GRADED SAND
GW	=	WELL GRADED GRAVEL
GM	=	SILTY GRAVEL

figure 2.3

CROSS-SECTION A-A'
CHEMTURA CANADA CO./CIE
Elmira, Ontario



SCALE: H: 1:1000
V: 1:250

LEGEND

WELL SCREEN

GROUNDWATER ELEVATION (SEPTEMBER 9, 2014) ▼346.79

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL

SILT, CLAYEY SILT OR SILTY CLAY

SHALE

FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

MODIFIED UNIFIED SOIL CLASSIFICATION

CL = CLAY
CI = SILTY CLAY
ML = SILT
SM = SILTY SAND
SP = POORLY GRADED SAND
SW = WELL GRADED SAND
GW = WELL GRADED GRAVEL
GM = SILTY GRAVEL

figure 2.4

CROSS-SECTION B-B'
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA002 JAN 23/2015

C SOUTH

C' NORTH

ELEVATION IN METRES (ABOVE MEAN SEA LEVEL.)

DISTANCE IN METRES

SCALE: H: 1:1000
V: 1:250

NOTE: GROUND ELEVATIONS BASED ON PRE-1993 SURVEY

OW43-3/5/11/29 · BH9-07 · MW9B-07 · BH9C-07 · BH8-07/MW8B-07 · OW42-4/7/12 · BH6-07 · OW41-3/6/12 · BH5-07 · OW40-6/13 · TP4-07 · BH11-07 · TP2-07 · BH10-07/ OW164-10 · OW164-36 · TP1-07 · OW7-3/6/ 12/26/29/ 39/d/s

FILL · UA1 · UA2 · UA3 · UAT · MU · MAT · ML · BEDROCK · SHALE · MAT/LAT · LAT · BR · SA

LEGEND

WELL SCREEN

GROUNDWATER ELEVATION (SEPTEMBER 9, 2014) ▼946.79

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL

SILT, CLAYEY SILT OR SILTY CLAY

SHALE

FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

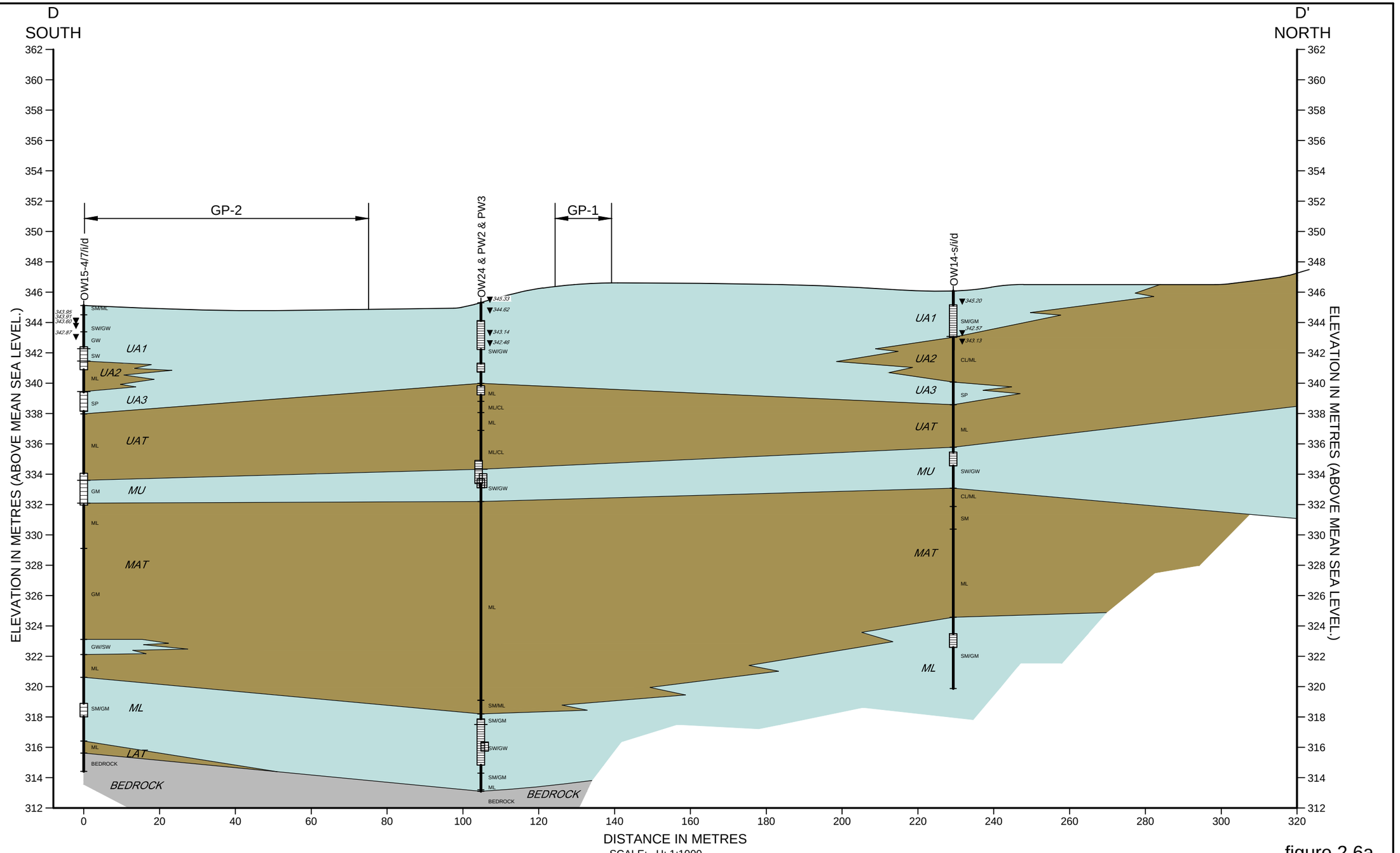
MODIFIED UNIFIED SOIL CLASSIFICATION

CL	=	CLAY
CI	=	SILTY CLAY
ML	=	SILT
SM	=	SILTY SAND
SP	=	POORLY GRADED SAND
SW	=	WELL GRADED SAND
GW	=	WELL GRADED GRAVEL
GM	=	SILTY GRAVEL

figure 2.5

CROSS-SECTION C-C'
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA002 JAN 27/2015



SCALE: H: 1:1000
V: 1:250

LEGEND

WELL SCREEN

GROUNDWATER ELEVATION (SEPTEMBER 9, 2014)

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL

SILT, CLAYEY SILT OR SILTY CLAY

SHALE

FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

MODIFIED UNIFIED SOIL CLASSIFICATION

CL	=	CLAY
CI	=	SILTY CLAY
ML	=	SILT
SM	=	SILTY SAND
SP	=	POORLY GRADED SAND
SW	=	WELL GRADED SAND
GW	=	WELL GRADED GRAVEL
GM	=	SILTY GRAVEL

figure 2.6a

CROSS-SECTION D-D'
CHEMTURA CANADA CO./CIE
Elmira, Ontario

D
SOUTH

D'
NORTH

RPE-5 (OFFSET)
RB-2
BAE-1
RB-1
RPE-4 (OFFSET)
RPE-3
RPE-3

OW37-5/11
OW8-4/s/d
OW38-5/6
OW36-5
OW34-5
OW32-3/6/8
OW28-2/5/6
OW26-9
OW39-4/6/9
OW164-36
BH10-07/
OW164-10

UAT
UAT
MAT/LAT
BEDROCK
BEDROCK

ELEVATION IN METRES (ABOVE MEAN SEA LEVEL.)

DISTANCE IN METRES

SCALE: H: 1:1000
V: 1:250

LEGEND

FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

WELL SCREEN

▼346.79 GROUNDWATER ELEVATION (SEPTEMBER 9, 2014)

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL
SILT, CLAYEY SILT OR SILTY CLAY
SHALE

MODIFIED UNIFIED SOIL CLASSIFICATION

CL = CLAY
CI = SILTY CLAY
ML = SILT
SM = SILTY SAND
SP = POORLY GRADED SAND
SW = WELL GRADED SAND
GW = WELL GRADED GRAVEL
GM = SILTY GRAVEL

figure 2.6b

CROSS-SECTION D-D'
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA002 JAN 27/2015

D
SOUTH

D'
NORTH

RPE-3

RPE-2

OW7-3/6/12/26/29/39/d/s

CH57

OW6-17/29/S

UAT

MAT

LAT

BEDROCK

ELEVATION IN METRES (ABOVE MEAN SEA LEVEL.)

DISTANCE IN METRES

SCALE: H: 1:1000
V: 1:250

LEGEND

FILL - FILL MATERIAL
UA1 - TOP BEDS, UPPER AQUIFER
UA2 - MIDDLE BEDS, UPPER AQUIFER
UA3 - BOTTOM BEDS, UPPER AQUIFER
UAT - UPPER AQUITARD
MU - MUNICIPAL AQUIFER
MAT - MUNICIPAL AQUITARD
ML - LOWER MUNICIPAL

WELL SCREEN

GROUNDWATER ELEVATION (SEPTEMBER 9, 2014)

SAND, SAND & GRAVEL OR SILTY SAND & GRAVEL

SILT, CLAYEY SILT OR SILTY CLAY

SHALE

MODIFIED UNIFIED SOIL CLASSIFICATION

CL = CLAY
CI = SILTY CLAY
ML = SILT
SM = SILTY SAND
SP = POORLY GRADED SAND
SW = WELL GRADED SAND
GW = WELL GRADED GRAVEL
GM = SILTY GRAVEL

figure 2.6c

CROSS-SECTION D-D'
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA002 JAN 27/2015

WELL ID	GROUNDWATER ELEVATION (m AMSL)	WELL ID	GROUNDWATER ELEVATION (m AMSL)
CH-41C	347.73	OW70-3	344.79
CRA3A	345.73	OW71-2	344.89
MW13-07	346.49	OW72-2	345.46
MW15-10	345.54	OW74-6	344.62
MW15-5	345.29	OW77-8	344.05
MW15-8	345.17	OW78-7	344.12
MW15-9	345.26	OW86-8	345.36
MW44-1	344.85	OW87-7	346.32
MW44-2	344.82	OW88-8	345.31
MW62-2	345.90	OW89-5	345.19
MW62-3	345.78	OW93-5	346.33
OW100-2	346.58	OW94-4	346.20
OW101-5	348.48	OW96-5	345.41
OW102-5	346.68	OW97-5	345.22
OW104-5	344.22	OW98-5	344.13
OW105s	344.10	OW99-3	344.08
OW10-6	344.00	RPW6-2-5	344.85
OW106-5	343.88	RPW6-5-6	344.67
OW107s	344.15	RPW6-6-5	344.75
OW110-5	344.69	RPW7-3-6	344.71
OW112-4	344.86	SS+270	345.37
OW113-4	344.73	SS+290	345.39
OW114-5	344.12	SS+310	345.38
OW115-5	344.39	SS+345	345.34
OW123-4	344.75	SS+385	344.98
OW124-6	344.30	SS+415	344.93
OW125-6	344.08	SS+430	345.11
OW126-6	343.98	SS+450A	344.92
OW127-4	345.38	SS+450B	344.92
OW129-6	343.52	SS+490	344.78
OW1-3	349.87	SS+500(East)	344.85
OW130-4	344.59	SS+500(West)	344.77
OW131-7	344.01	SS+540	344.82
OW132-6	344.22	SS+575	344.80
OW133-6	344.03	SS+615	344.73
OW136-2	347.50	SS+635	344.62
OW137-3	346.88	SS+660	344.49
OW138-3	345.43	SS+690	344.49
OW139-2	345.38	SS+720	344.41
OW140-2	345.07	SS+735A	344.34
OW141-2	344.83	SS+735B	344.47
OW142-2	344.25	SS+770	344.33
OW143-3	344.13	SS+800	344.23
OW144-3	343.89	SS+880	344.00
OW145-4	343.72	SS+915	343.98
OW146-3	343.95	SS+920	343.94
OW147-4	345.36	UOW+460	344.78
OW14s	345.30	UOW+510	344.77
OW150-2	345.54	UOW+540	344.72
OW152-4	344.78	UOW+610	344.01
OW153-4	345.37	UOW+630	344.35
OW15-4	343.91	UOW+645	344.27
OW157-6	344.03	UOW+720	343.95
OW162-3	346.67	USW+385	344.98
OW16-3	343.97	USW+500	344.78
OW18s	346.14	USW+660	344.47
OW19s	346.14	OW6s	357.72
OW20s	346.72	OW7-3	357.74
OW2-3	348.22	OW148-3	357.48
OW24S2	344.12	OW149-7	357.30
OW43-3	345.26	OW156-4	357.30
OW48-4	344.17	OW2i	348.35
OW50-5	344.41	OW7-12	348.70
OW50-6	344.37	OW7-6	357.39
OW52-4	344.77	OW7s	355.20
OW53-5	344.76	OW8-4	346.69
OW55-5	344.80	OW8s	346.35
OW58-5	345.16	OW26-9	348.71
OW62-5	344.75	OW28-5	350.36
OW63-7	344.35	OW32-3	348.93
OW64-5	345.55	OW37-5A	346.83
OW65-5	346.22	OW40-6	348.42
OW66-6	345.57	OW162-7	343.95
OW67-5	344.15	OW164-10	348.55
OW68-5	344.01		

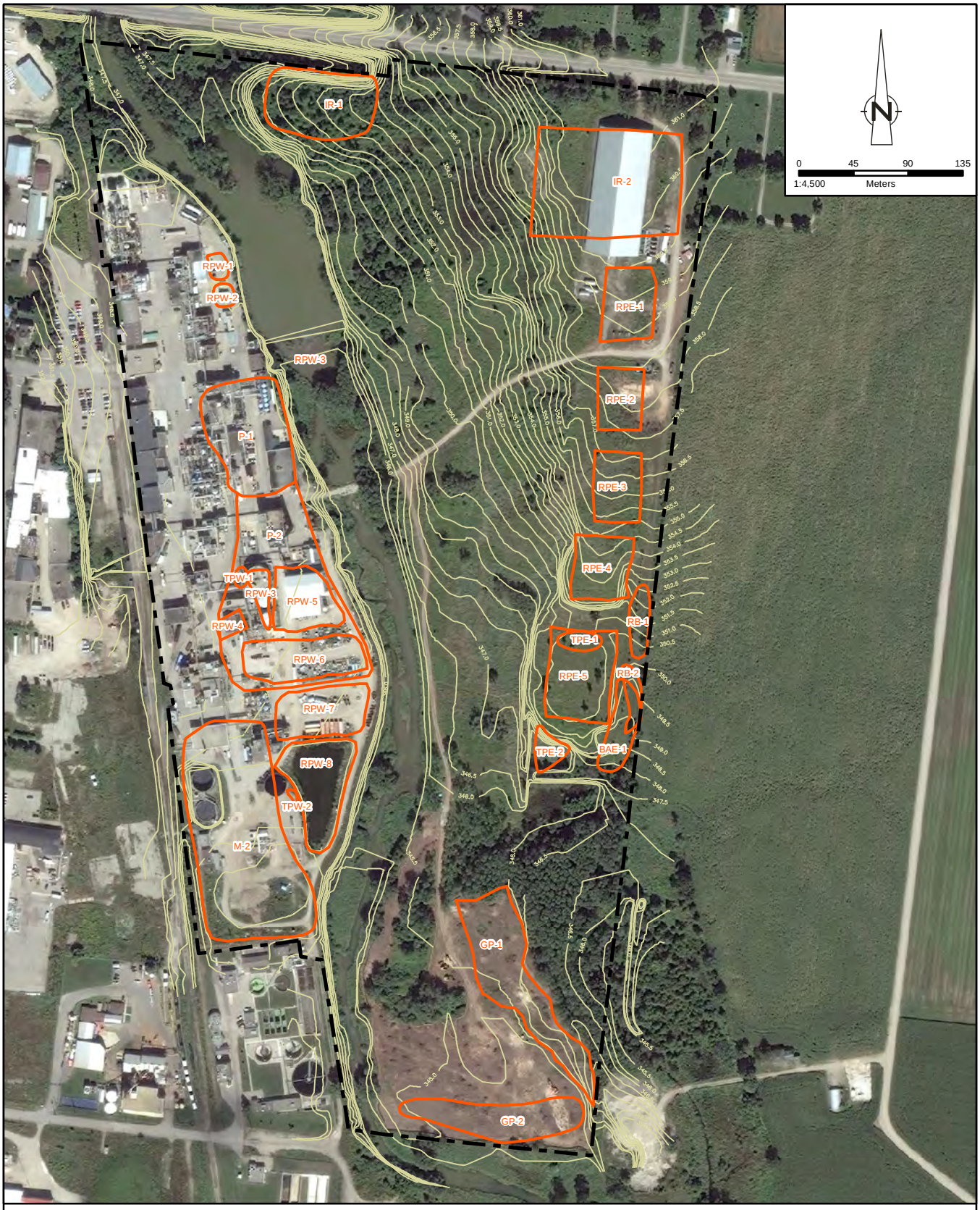
LEGEND

- OW153-4 — UA1 MONITORING WELL
- OW7-3 — SA MONITORING WELL
- OW7-6 — OTHER MONITORING WELL
- U+710 — EXTRACTION WELL
- SS+310 — SURFACE WATER ELEVATION MONITORING STATION
- USW+385 — STILLING WELL
- 345.68 — GROUNDWATER ELEVATION (m AMSL)
- 345.0 — UA1 GROUNDWATER ELEVATION CONTOUR (m AMSL)
- 357.5 — SA GROUNDWATER ELEVATION CONTOUR (m AMSL)
- GROUNDWATER FLOW DIRECTION
- AREA WHERE UA1 DOES NOT EXIST

figure 2.7

GROUNDWATER ELEVATION CONTOURS
SEPTEMBER 9, 2014
CHEMTURA CANADA CO./CIE
Elmira, Ontario

11725-12(027)GN-WA004 JAN 28/2015



Source: © 2014 - TerraServer®
Coordinate System: NAD 1927 UTM Zone 17N
Note: Ground elevations based on pre-1993 survey

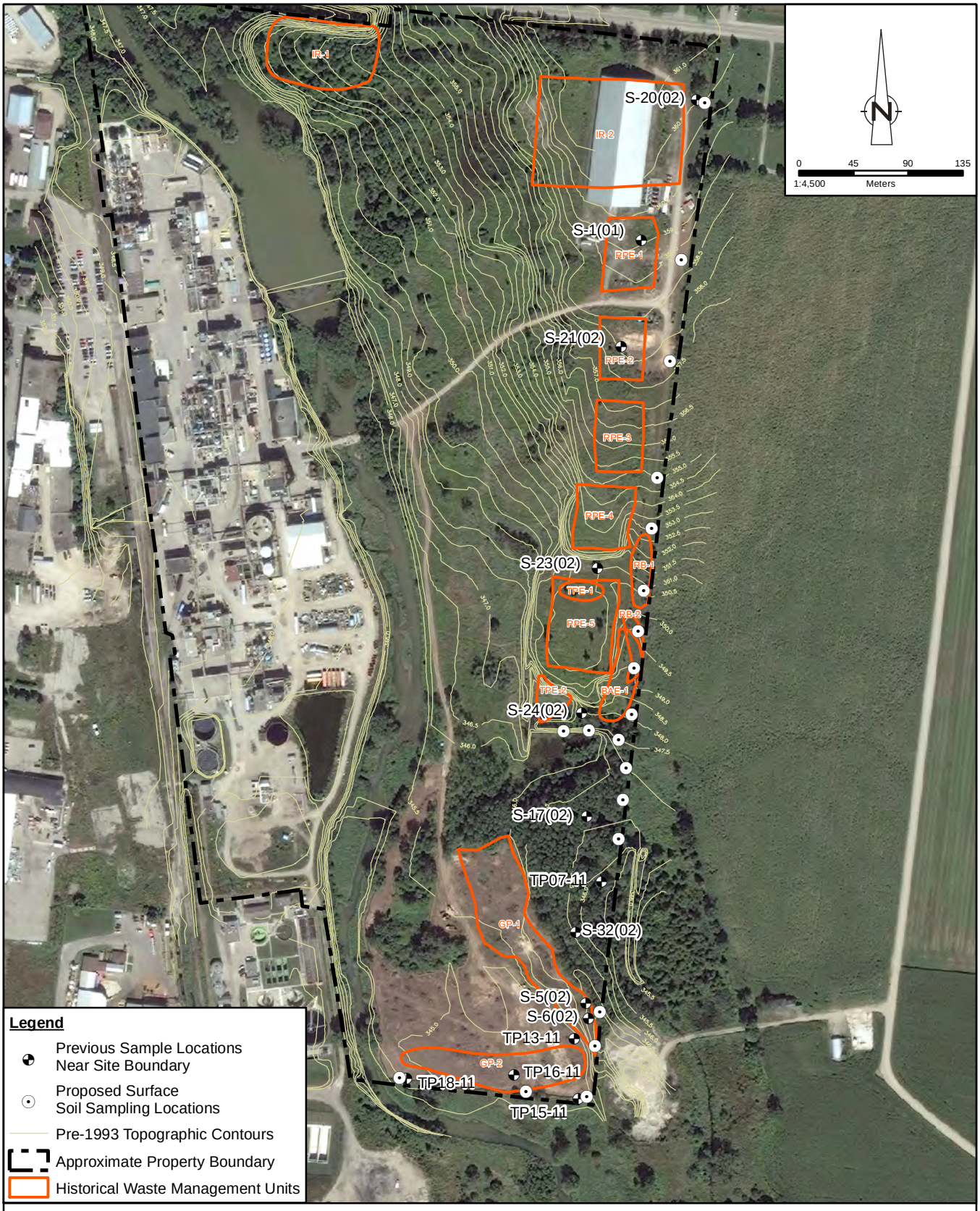
Legend

- Pre-1993 Topographic Contours
- Historical Waste Management Units
- Approximate Property Boundary

figure 3.1

EAST SIDE WASTE MANAGEMENT UNITS
CHEMTURA CANADA CO./CIE
Elmira, Ontario

011725-12(027)GIS-OT004 Jan 29/2015

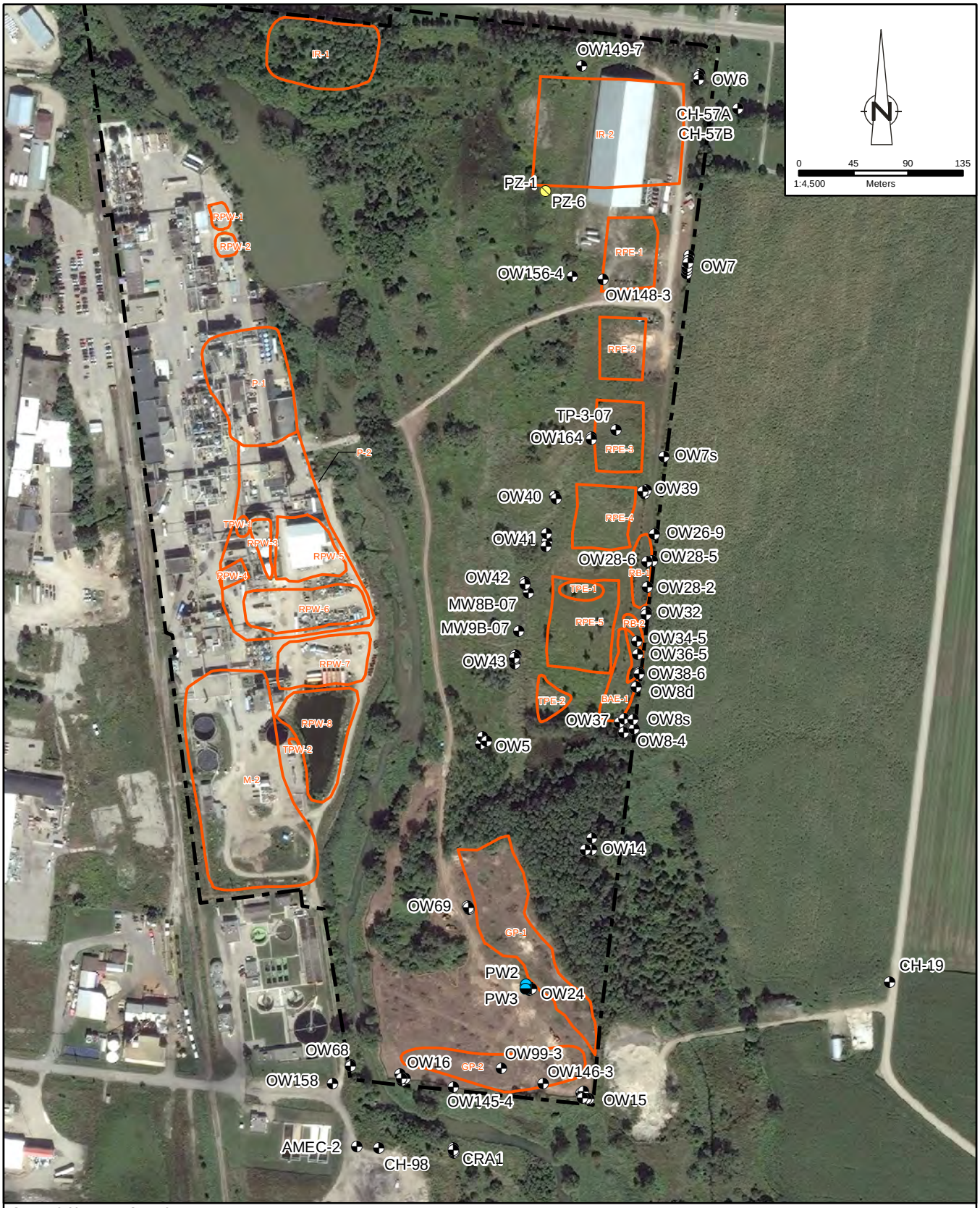


Source: © 2014 - TerraServer® Coordinate System: NAD 1927 UTM Zone 17N

figure 4.1

PROPOSED EAST SIDE SURFACE SOIL SAMPLING LOCATIONS
EAST SIDE SURFACE SOIL AND GROUNDWATER INVESTIGATION
CHEMTURA CANADA CO./CIE
Elmira, Ontario

011725-12(027)GIS-OT002 Jan 29/2015



Source: © 2014 - TerraServer®
Coordinate System: NAD 1927 UTM Zone 17N

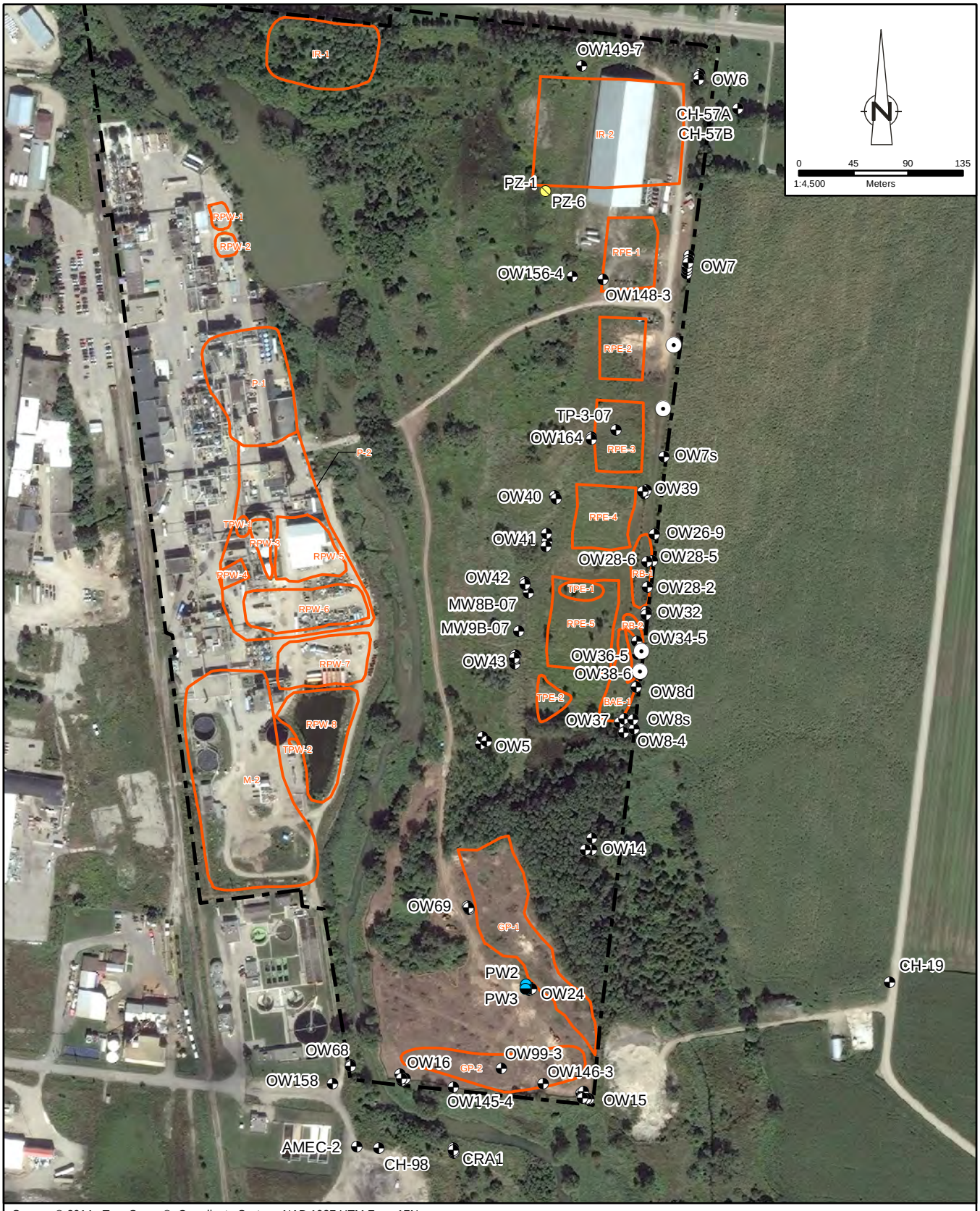
Legend

- Extraction Well
- Observation Well
- Piezometer
- Approximate Property Boundary
- Historical Waste Management Units

figure 5.1

EAST SIDE MONITORING WELLS, PIEZOMETERS AND EXTRACTION WELLS
CHEMTURA CANADA CO./CIE
Elmira, Ontario

011725-12(027)GIS-OT001 Jan 29/2015



Source: © 2014 - TerraServer®, Coordinate System: NAD 1927 UTM Zone 17N

Legend

- Proposed Temporary Well
- Extraction Well
- Observation Well
- Piezometer
- Approximate Property Boundary
- Historical Waste Management Units

figure 5.2

PROPOSED EAST SIDE TEMPORARY WELLS
CHEMTURA CANADA CO./CIE
Elmira, Ontario

011725-12(027)GIS-OT003 Jan 29/2015

TABLE 3.1

WASTE MANAGEMENT SUMMARY TABLE
EAST SIDE SURFICIAL SOIL AND GROUNDWATER INVESTIGATION
CHEMTURA CANADA CO./CIE

Waste Management Area	*Waste Types*	*Operation*	*Area (ha)*	*Status*
IR-1	Iron oxide sludge, chlorobenzene, DPA tars	1965 - 1967	0.46	Closed and covered
IR-2		1970	1.05	Closed and covered
RPE-1	Liquid wastes from aniline and nitrobenzol processing, thiokol wastes, 2,4-D wastewater, polyester resins	1946 - 1970	0.66	Closed and covered
RPE-2				Excavated in 1970 (RPE-4 and RPE-5)
RPE-3				Excavated and consolidated in RPE-4 and RPE-5 in 1970, residual waste and stained soils excavated in 2009
RPE-4 and RPE-5	Contaminated soils from Canagagigue Creek, waste from RPW-3, RPW-5, RPW-6, RPW-7, RPW-8,RPE-3, TPE-1, TPW-1, TPE-2, drums from BAE-1	1950 -1970 (unlined), 1970 – 1990 (lined), 1990 – 199? Covered	0.64	Lined in 1970, capped with a synthetic cover in 1990 and excavated and consolidated in the Buried Waste Building in 1993 and 1994
TPE-1 and TPE-2	Waste tars	1970	0.11	Excavated and consolidated in RPE-4 and RPE-5
BAE-1	Drum burial of MPCA and 2,4-0 acids and esters, sludge from Building 15 sump, waste tars from 2,4,5-T processes	1950s - 1960s	0.15	Excavated and re-buried in RD-1 and RD-2
RD-1 and RD-2	Re-buried drums form BAE-1	1970 - 1987	0.15	Excavated and consolidated in RPE-4 and RPE-5
GP-1 and GP-2	Overflow from the east pits	1941 - 1970	0.59	

TABLE 7.1

SUMMARY OF PROPOSED SURFACE SOIL SAMPLING LOCATIONS
EAST SIDE SURFICIAL SOIL AND GROUNDWATER INVESTIGATION
CHEMTURA CANADA CO./CIE

Conceptual Area	***Proposed Samples***	***Proposed Analyses***
Former Waste Disposal Areas (9 Samples Total)	9	Dioxins, Furans, OC Pesticides, Chlorophenols
	3	PHC, VOCs
Wetland Area South of RPE-5 (6 Samples Total)	6	Dioxins, Furans, OC Pesticides, Chlorophenols
	1	PHC, VOCs
GP-1, GP-2, and Southeast Area (5 Samples Total)	5	Dioxins, Furans, OC Pesticides, Chlorophenols
	2	PHC, VOCs
TOTAL SAMPLING LOCATIONS	**20**	

TABLE 7.2
SUMMARY OF GOUNDWATER SAMPLING RECOMMENDATIONS
EAST SIDE SURFICIAL SOIL AND GROUNDWATER INVESTIGATION
CHEMTURA CANADA CO./CIE

Well	*Status*	*Last Sample Date*	*NDM (µg/L)*	*Chlorobenzene (µg/L)*	*Comments*	*Recommendation*
CH-57B	OK	1991	0.0815	ND(0.06)	Trace SVOCs	Sample[(1)(2)]
OW7-3	OK	1996	0.013	1.8	No VOCs or SVOCs detected	Sample[(1)(2)]
OW7-6	OK	1994	1.36	ND(0.5)	No VOCs detected	Sample[(1)(2)]
OW7s	OK	2007	Not Analyzed	ND(0.4)	No VOCs detected	No Further Action
OW39s	Abandoned	No Data				No Further Action
OW26-9	OK	2007	No Data	ND(0.1)	No VOCs detected	Sample[(1)(2)]
OW28-5	OK	2007	10.3 (1990)	ND(0.1)	No VOCs detected	Sample[(1)(2)]
OW32-3	OK	2013	ND(0.01)	ND(0.10)	No VOCs or SVOCs detected	No Further Action
OW34-5	Abandoned	No Data				No Further Action
OW36-5	Abandoned	1992	No Data	No Data	Benzene = 33,000 µg/L; 2,4,5-T = 2,800 µg/L	Temporary well and sample[(1)(2)]
OW38-5	Abandoned	1986	No Data	No Data	Benzene = 1,700 µg/L; 2,4,5-T = 6,200 µg/L	Temporary well and sample[(1)(2)]
OW38-6	OK	2007	No Data	ND(0.1)	No VOCs detected	No Further Action
OW8s	OK	2007	0.013 (1990)	ND(0.1)	No VOCs detected	No Further Action
OW8-4	OK	2006	ND(0.01)	ND(0.1)		No Further Action
OW14s	OK	1990	0.01	ND(0.27)	No VOCs or SVOCs detected	No Further Action
OW15s	Abandoned	1996	0.36	11.8		No Further Action
OW15-4	OK	2011	ND(0.01)	2.8	dioxin and furans not detected	Sample[(3)]
OW146-3	OK	2011	ND(0.01)	3.4	dioxin and furans not detected	Sample[(3)]
OW99-3	OK	2011	ND(0.002)	24	dioxin and furans not detected	Sample[(3)]
OW145-4	OK	2011	ND(0.01)	15	dioxin and furans not detected	Sample[(3)]
OW16s	Abandoned	1995	9.35	81		No Further Action
OW16-3	OK	2011	ND(0.01)	4.1	dioxin and furans not detected	Sample[(3)]

Notes:
(1) Analytical parameters include NDMA, VOCs, SVOCs and chlorinated herbicides and OC pesticides.
(2) If concentrations of chlorophenols, 2,4-dichlorophenoxyacetic acid (2,4-D), or 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) are greater than the Ontario Drinking Water Quality Standards (ODWS) in groundwater samples, CRA will recommend that samples also be collected and submitted for analysis of dioxins and furans.
(3) Analytical parameters include NDMA, VOCs, SVOCs, dioxins, furans, chlorinated herbicides and OC pesticides.