3. HISTORICAL INFORMATION

3.1 Salt Mining

The Michigan Basin is one of the largest areas of halite (rock salt-NaCl) deposition in the world. Salt has historically been mined either directly in solid form as rock salt or as natural or artificial brine pumped through solution mining wells. The area beneath Detroit and Windsor within the Michigan Basin is currently mined using both solution mining techniques and conventional room-and-pillar excavation methods. Generally, the solution wells extended to depths of 335 to 490 m (1,100 to 1,600 feet).

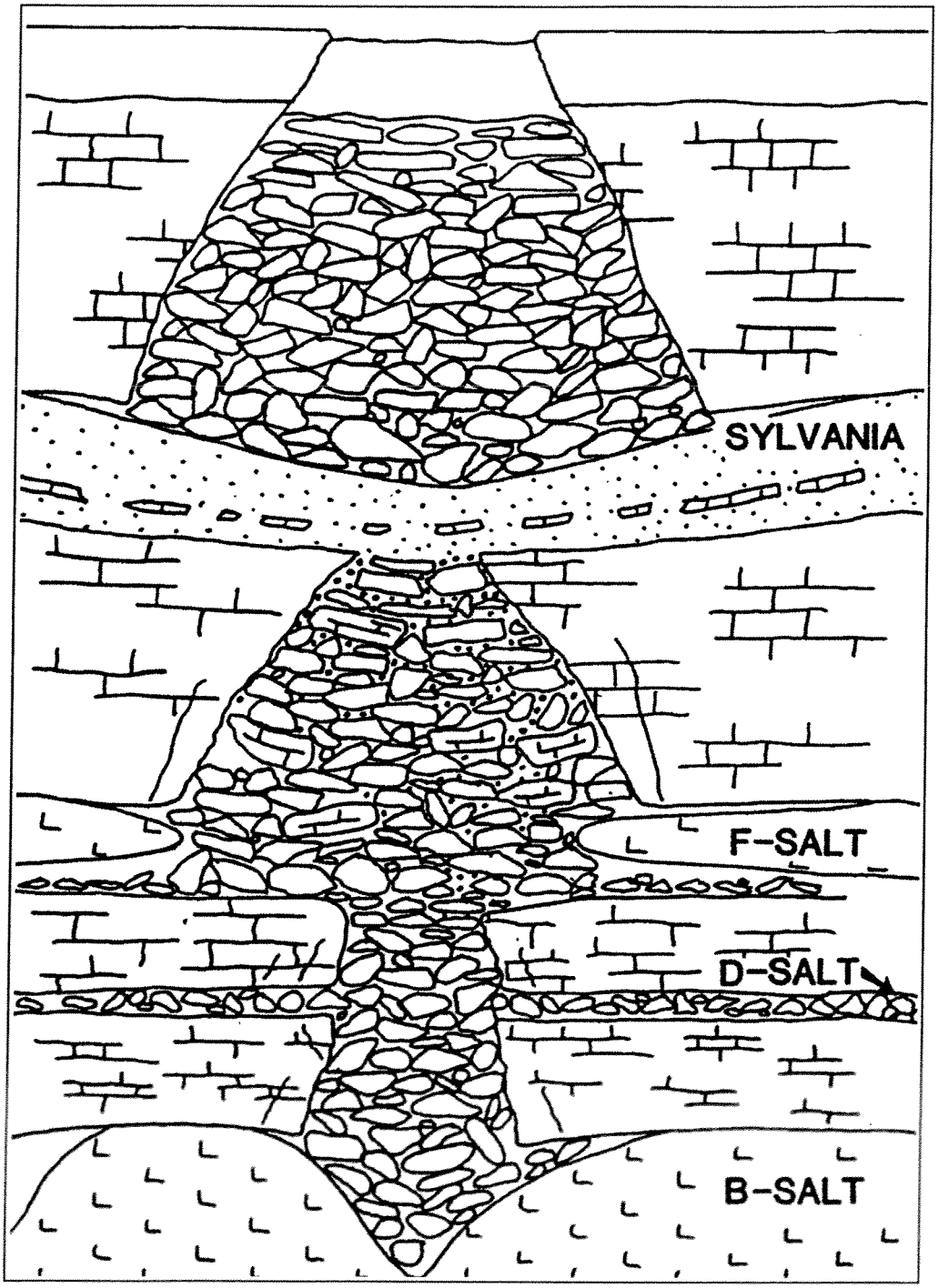
Solution mining consists of introducing fresh water from the surface down a well casing between an outer casing and a central tube (Figure 3-1). The brine produced from the salt dissolving in the water is recovered through the central tube. Cavities using this method are usually larger at the top of the stratum than at the bottom, because the fresh water tends to stratify above the denser salt brine in the cavity. The fresh water dissolves salt more rapidly near cavity roofs than at the base of the cavities which are in contact with saturated brine. This results in an inverted cone-shaped or "morning glory" shaped cavity.

Solution cavities often coalesce with adjacent cavities to form composite cavities called "galleries." When this occurred historically, one or more of the wells were then converted to water inlet wells and the brine was pumped out through other wells in the interconnected system (Figure 3-1). As production continued in the gallery, large spans of unsupported roofs were sometimes created, which, in turn, could cause sagging, downward flexure, and local delamination of rock units resulting in local roof collapse and eventual surface subsidence in some instances. This surface subsidence is commonly known as a "sinkhole."

Subsidence and/or collapse often progresses upwards as a "chimney effect" on a relatively steep angle (generally 15-degrees or steeper) from the outside edges of the brinefield (Figure 3-2). Several theories have been published on the subsidence progression to the surface, the more notable of which attributes surface "daylighting" to failure of the Sandstone Sylvania Formation at a depth of approximately 152 to 183 m (500 to 600 feet). According to the theory, the sandstone disintegrates under the induced compression from rock mass sagging, and the fragments filter downwards as granular material into cavities below. This results in a cavity at a depth at approximately 152 m (500 feet) instead of the original cavity depth. This mechanism would explain why theoretical "bulking" of broken rock pieces would not be sufficient to fill the cavities before daylighting occurs.

The solution mining areas are of concern for this project, as they present the potential for future ground collapse and related adverse effects on elements of the proposed crossing structure. Additionally, at least two previous collapses have occurred in the region: at Point Hennepin near Grosse Ile, Mich., and in Windsor, Canada, in the X-10 crossing zone as shown in Figure 1-1. Significant settlements have also occurred beneath a known well field in Wyandotte, Mich. Both Grosse Ile and Wyandotte are several miles downriver from the DRIC crossing corridors. All of the known collapses have been in large interconnected brine fields (galleries).

Figure 3-2
Detroit River International Crossing Study
Conceptual Representation of Sinkhole Propagation to Surface



Source: Ontario Geological Survey

Historic information indicates that prior to 1916, at least one solution mining well was located to the west of the better-documented Solvay wells, also on the Solvay parcel (near the edge of the X-10 corridor). This well is documented on only one relatively early historic map, so the location is not considered as reliable as the other documented locations on the site. Further, it is certainly possible that more than one brine well existed at this location.

Research for this project has also uncovered the existence of three previously-operated deep disposal wells on the former Solvay parcel. The wells were drilled from 1969 to 1978 to depths of greater than 1,200 meters (4,000 feet). The wells were used to inject hazardous waste into permeable rock formations (Munising Formation) deep within the ground. The wells are thought to have been plugged in 2004 based on court proceedings in which the operators of the hazardous waste injection operation were prosecuted for illegal activities. Disposal Well #2 was subsequently plugged in December 2007. Available lithologic logs do not indicate the existence of solution cavities encountered during drilling of any of these wells, one of which is apparently about 120 meters (400 feet) from a documented Solvay brine well. From this information, it appears that, at least in this location, the brine mining activities did not create cavities more than 120 meters (400 feet) from the actual brine well. However, it should also be noted that the logs of the injection wells do not contain great detail, and may not have documented small cavities that were encountered during drilling. Some loss of circulation is also noted in these logs in the upper Devonian strata, indicating that natural solutioning of the limestone and dolomites may have taken place historically (as later concurred in the drilling program).

3.2.2 X-11 Corridor

At least four brine well locations and/or solution mining areas are documented within the approximately 900-meter-wide (3,000-foot-wide) X-11 corridor. All are documented through relatively older sources, which may be less reliable with respect to exact location or existence of the wells. All of the documented brine wells and/or processing areas are reported to have been located in the western half of the X-11 corridor (as shown on Figure 1-7).

Historic information indicates that both JI Carter Salt Company (Carter Salt) and Solvay may have participated in solution mining operations within the corridor. Carter Salt is thought to have operated a salt block (brine processing) plant between present day Dragoon and Military Avenues, on the north side of the existing railroad tracks. The exact numbers and locations of potential solution mining wells are not known, although various records appear to locate wells and/or brine processing in at least three locations. In any case, it is likely the wells would have been drilled to approximately 350 to 375 meters (1,100 to 1,200 feet) and located adjacent to or in close proximity to the block location.

Other early maps show Solvay maintained a salt block (brine processing) plant near present-day Campbell and Cavalry Streets, just south of Jefferson Avenue. Although exact numbers and locations of potential solution mining wells are not known, they would have likely been located adjacent to or in close proximity to the salt block location.