

## Final Report

**Project Title:** Targeted monitoring, outreach and education to reduce exposure to brick kilns emissions and assess impact on childhood asthma in San Luis Rio Colorado, Sonora.

**Agreement Number:** TAA06-028

**Principal Investigator and Organization:** James Anderson, Arizona State University

### **Overview.**

This project was a continuation of a project focused on assessing the air quality problems associated with traditional brick kilns in San Luis Rio Colorado, informally through a simple survey assessing the health effects of the smoke on colonia residents and their perceptions of the health effects, and continuing efforts to convince brickmakers to relocate their kilns (but not their homes) to an area south of the city near the municipal wastewater treatment plant. For a variety of reasons, the original project design was altered in the middle of the grant period to include the participation of the Regional Center for Border Health (RCBH) in Somerton, Arizona and Dr. Marco Antonio Ramirez Wakamatzu, regional director of Servicios de Salud de Sonora. Dr. Wakamatzu is the chief public health official for San Luis Rio Colorado. This greatly strengthened the project with regard to its principal objectives, but changed the way in which some of the specific tasks were approached. The change in project organization also delayed the completion of the project by about 6 months. However, the alliances formed with the Regional Center for Border Health and Servicios de Salud de Sonora will be a significant asset for any future work.

These were the tasks as originally defined:

Task 1. Coordinate with municipal and school officials.

Dr. Wakamatzu did most of the coordinating with municipal and school officials. The school that we worked with in La Grullita is one that we have worked with in a previous project. Because of his position as chief public health officer for the area, cooperation of city and school officials as well as residents of the brick-making colonias was excellent. Also, the PI met with municipal officials at two binational meetings in Somerton, Arizona and San Luis R.C. Further meetings will follow in the coming year even though the project is completed.

Task 2. Design asthma survey.

A two-page survey was designed jointly by J. Anderson of ASU, Cluadia Ulloa of RCBH and Dr. Wakamatzu of Servicios de Salud de Sonora. A copy of the survey is included as the compiled results. Because of confidentiality and human subjects issues, we will retain all the completed surveys but not include them in this report.

Task 3. Monitor indoor/outdoor aerosol at school.

We monitored at an elementary school in Colonia Topahue in the La Grullita district of San Luis R.C. during October and November 2007. The results are discussed in the section on PM10 results below.

Task 4. Coordinate w/school to obtain absentee data.

We've had some difficulty in this area and Dr. Wakamatzu is still working on it.

Task 5. Monitor indoor/outdoor aerosol at residences.

We monitored PM10 at two residences, one in Colonia Mezquite II and one in Colonia Topahue, during October and November 2007. Results are discussed in the section below in PM10 results. The PM10 data are included on a CD which accompanies this report.

Task 6. Conduct asthma survey.

Ten public health nurses from Servicios de Salud de Sonora conducted the surveys the two brick-making colonias. Approximately 400 households were contacted and a total of 199 agreed to participate, 69 in La Grullita and 131 in Colonia Mezquite II. The results are discussed in a separate section below. We had originally intended to use promotores/promotoras for the surveys. However, the surveys contained some politically sensitive questions and we felt that the nurses, who routinely work in these colonias performing public health functions such as vaccinations, would be more trusted by the residents. We also decided that the nurses could conduct a significant part of the outreach during their visits to homes and this outreach could include residents who were unwilling to participate in the survey.

Task 7. Analyze collected data and prepare outreach material.

As discussed above, we altered our approach to outreach about the health hazards from kiln smoke and made home visits by the public health nurses a significant part of the outreach. In addition to discussing the issues, they handed out brochures on asthma to each home they visited.

We also had a front-page story in the local newspaper *La Cronica* on Feb. 16, 2008. We are jointly working on a brochure in Spanish to supplement the asthma brochure that we used. The results of the project's work will be included in training material for the classes that RCBH conducts for local health workers.

Task 8. Conduct outreach program.

The principal outreach effort conducted during the project period was, as discussed above, conducted by the ten public health nurses as they visited about 400 households in the two colonias. In addition to the on-going training efforts on respiratory health at RCBH, we plan to work with the school in Colonia Topahue on a further outreach effort to parents of their students. Because both Dr. Wakamatzu and RCBH have a long-term presence in the community, the contribution of this project to outreach efforts on respiratory health with regard to brick-kiln smoke will not end with project's completion.

The results of the study and discussion of future plans were presented at five binational meetings held in Arizona and Sonora. The meetings are listed below and the Powerpoint files and agendas are included on a CD that accompanies this report.

## Surveys of Colonias Ladrilleras

Below is an example of a completed survey form (with names and address redacted, since some responses may contain confidential information that only the public health authorities need to know).

The increased survey participation of residents of Colonia Mezquite II versus those of La Grullita is not simply a coincidence. The leaders of the brick-makers in Colonia Mezquite II are active in promoting change and seem more aware of the health hazards of the smoke. In Colonia Mezquite II, our outside monitoring in the previous work and indoor monitoring in this study was done at the residence of one of these leaders. In La Grullita we found more cooperation with the elementary school and its Parent Associations than with the brick-makers, who seem more reluctant to change.

One historical issue that needs to be kept in mind is that the two colonias were previously outside the city limits and were indeed part of previous relocation efforts. The brick-makers in Colonia Mezquite II indicated that their current area was originally intended only for brick-makers but that many families not associated with brick making had later moved into the colonia. The city continues to grow and eventually relocation will not be a sufficient solution to the brick kiln smoke issue. If traditional brick making is to continue the methods will have to be changed.

The surveys indicate a broad awareness in the colonias that kiln smoke adversely impacts the health of both children and adults and those who responded were quite willing to indicate their awareness. The issue of the use of old painted boards (that often have leaded paint) as fuel was more sensitive and the survey results below reflect this. There is some awareness that burning painted boards can create a health problem and some respondents indicated directly or indirectly (by declining to answer) awareness that painted boards were sometimes used in the kilns. However, none of respondents would say that painted boards were used in their brick operations.

There are other issues with kiln fuels, since almost all of the fuel is scrap material either from *maquiladoras* (especially particleboard with resin as a binder and plastic facing) or from demolition (the source of the painted boards). Piles of old tires are also evident in the kiln yards but our experience from talking with the brick-makers is that the tires are rarely if ever used as fuel because the resulting bricks are not saleable.

The reported rate of asthma in children in La Grullita (14 in 141) is significantly higher than the reported rate in Colonia Mezquite II (12 in 278). While the survey is not a statistically valid sampling of the two populations, this difference suggests possible differences in exposure rates. One qualitative observation is that kilns closely surround the elementary school in La Grullita whereas the corresponding school in Colonia Mezquite II is not as close to kilns. There are undoubtedly other factors, including perhaps the informal nature of the survey methods although such a difference in apparent children's asthma rates invites further attention.

**Estudio de Exposición a los Humos de las Ladrilleras**  
San Luis Río Colorado Sonora México  
Cuestionario

Fecha: 11/01/08 Domicilio: [Redacted] AGEB: 194-2 Manzana: 16  
 Ciudad: SLEC Código Postal: 83488 Persona Entrevistada: [Redacted] Teléfono: \_\_\_\_\_  
 Niños Incapacitados: Si  No  Que Forma de Incapacidad?  Autismo  Síndrome Down  Espina Bífida  1. Otro: \_\_\_\_\_ Niños con Asma: Si  No   
 Enfermedades del pulmón? Si  No   
 Colonia: Nezquile Fam Loero Mateo  2. Otro: \_\_\_\_\_

No. de Casa	Adulto/Niño	Edad	Sexo	Trabaja usted como Ladrillero? Si si, ver pagina 2 sección B.	A que escuela asiste el niño/a?	Información sobre los niños		Hay fumadores en su hogar?
						Falta mucho el niño/a a la escuela por problemas de Asma o enfermedades del pulmón? Con que frecuencia?	Toma usted medicamentos por Asma o enfermedades del pulmón?	
	<i>Nezquile dar datos</i>							
3		20	Fem					
3		17	Masc					
3		15	Masc					
3		14	Masc		Sec. Fel 69	NO		
		12	Fem		Felipe Reyes	NO		
		9	Fem		" "	NO		
		12	Fem					
		49	Masc	SI				

Sección A:	Si	No
1. Esta usted conciente sobre los efectos secundarios que causa el humo?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2. Sabia usted que el plomo causa problemas de la salud?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3. Sabia usted que ciertos materiales como quemar cartones con pintura contienen plomo?	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Sección B:	Si	No	Cada Cuanto?
1. Usa usted cartones con pintura? Si si, cada cuanto?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
2. Quema usted llantas para hacer ladrillos? Si, si cada cuanto?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
3. Sabe usted si otros ladrilleros queman cartones con pintura? Si queman llantas?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
4. Le gustaría a usted que movieran las ladrilleras al sur de la ciudad?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5. Si se les enseñara otros métodos de hacer ladrillos, cambiarían a las nuevas maneras?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Para el Promotor:	Si	No	Comentarios
1. Le Proporciono información sobre la salud a la familia?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
2. Estaba la familia dispuesta a discutir o proporcionar información?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
3. Le proporciono usted información sobre el asma y la relación a la contaminación del aire? Si si, que materiales?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Folleto
4. Hay servicios disponibles en la comunidad sobre la contaminación del aire?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
5. La familia necesita seguimiento? Si si, cuando?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
6. Numero de contactos que se necesitaron para completar encuesta.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	2

**Comentarios:**  
 personas inconformes porque no hay igualdad  
 sacaron a la ciudad y dejaron a las libres.  
 y son como 15 ladrilleras de 22 a 14'

Firma del Promotor: Enb Inceas F. Fecha Completado: 10/01/08

A total of 199 surveys were completed by ten (10) Public Health Nurses in a 3-week period. Approximately 400 homes were visited to complete the goal of 200 surveys. Community Health Workers took informational brochures about asthma and other educational materials to educate the families of the effects of smoke and lead. The following table shows the breakdown of total surveys completed by colonia and the geographical system used by the public health workers (AGEBs) .

Colonias	Total Number of Surveys
Grullita	68
Mezquite II	131
<i>Total</i>	<b>199</b>

**Colonia Grullita**

Community Health Workers completed 68 door-to-door surveys in 2 AGEB’s. The following table shows the breakdown of surveys completed by AGEB’s.

Colonia Grullita	Total Number of Surveys
AGEB 173-0	27
AGEB 200-A	41
<i>Total</i>	68

Demographic and medical history information was requested. There were a total of 14 children with Asthma, 4 adults with Asthma and a total of 10 people with pulmonary disease. The following table shows the number of children under 5 per AGEB and other demographic information about Colonia Grullita.

	173-0	200-A	Total
Children with Asthma	7	7	14
Adults with Asthma	3	1	4
Pulmonary Diseases	6	4	10
Other Complications*	0	0	0
Children under 5 years of Age	11	18	29
Children 6-18 years of Age	38	74	112
Adult Males	30	49	79
Adult Females	40	46	86

\*Other complications include allergies, bronchitis, pneumonia and other respiratory diseases.

Community Health Workers surveyed the households for their level of awareness of some of the effects that smoke can cause. Overall, residents understand the secondary effects of smoke of the brick kilns and understand that lead causes health problems. About half of the households surveyed were unaware that by burning painted boards the smoke contained lead.

Grullita – Awareness	Response
Are you aware of the secondary effects caused by the smoke of the brick kilns?	83% responded yes
Did you know that lead causes health problems?	83% responded yes
Did you know that some materials, like burning painted boards, contain lead?	57% responded yes
10% No answer or no comment	

The survey included a section for brick maker’s education of the secondary effects of smoke and lead. Out of the 68 surveys completed in Colonia Grullita, 25% of them were brick makers.

Grullita – Brick Makers	Response
Do you use painted boards?	100% said no
Do you use tires to make bricks?	100% said no
Do you know if other brick makers use painted boards or tires for making bricks?	12% said yes; 88% said no
Would you like the brick kilns to be moved to the south side of the city?	47% said yes; 24% said no; 29% no comment
If they teach you new ways to make bricks, would you change?	76% said yes; 12% said no; 12% no comment

There is a clear disconnect in admitting whether they used painted boards and their perception of whether painted boards are used in general.

### **Colonia Mezquite II**

Community Health Workers completed 131 door-to-door surveys in 3 AGEBS. The following table shows the breakdown of surveys completed by AGEBS.

Colonia Mezquite II	Total Number of Surveys
AGEB 194-2	41
AGEB 169-4	11
AGEB 168-A	79
<i>Total</i>	<i>131</i>

Demographic and medical history information was requested. There were a total of 12 children with Asthma, 7 adults with Asthma and a total of 5 people with pulmonary disease. In addition, 31 residents reported suffering from other complications, including allergies, bronchitis, TB, pneumonia and other respiratory diseases. The following table shows the number of children under 5 per AGEBS and other demographic information about Colonia Mezquite II.

	194-2	169-4	168-A	Totals
Children with Asthma	4	0	8	12
Adults with Asthma	2	0	5	7

Pulmonary Diseases	3	0	2	5
Other Complications*	8	1	22	31
Children under 5 years of Age	23	8	41	72
Children 6-18 years of Age	53	19	134	206
Adult Males	50	14	95	159
Adult Females	50	12	90	152

\*Other complications include allergies, bronchitis, TB, pneumonia and other respiratory diseases.

Community Health Workers surveyed the households for their level of awareness of some of the effects that smoke can cause. Overall, residents understand the secondary effects of smoke of the brick kilns and understand that lead causes health problems. About half of the households surveyed were unaware that by burning painted boards caused lead.

Mezquite II – Awareness	Response
Are you aware of the secondary effects caused by the smoke of the brick kilns?	87% responded yes
Did you know that lead causes health problems?	86% responded yes
Did you know that some materials, like burning painted boards, contain lead?	55% responded yes
2% No answer or no comment	

The survey included a section for brick maker's education of the secondary effects of smoke and lead. Out of the 131 surveys completed in Colonia Mezquite II, 10% of them were brick makers.

Mezquite II– Brick Makers	Response
Do you use painted boards?	100% said no
Do you use tires to make bricks?	92% said no; 8% no comment
Do you know if other brick makers use painted boards or tires for making bricks?	85% said no; 15% no comment
Would you like the brick kilns to be moved to the south side of the city?	62% said yes; 23% said no; 15% no comment
If they teach you new ways to make bricks, would you change?	85% said yes; 8% said no; 7% no comment

Again, the issue of painted boards was answered in a way that indicated knowledge of it as a problem but an unwillingness to admit such boards were used. We observed old painted boards in the fuel piles in both colonias.

## **PM10 Monitoring**

Our previous Border 2012 project involved outdoor monitoring of PM10 and PM2.5 in these same two colonias. However, much of the time during a typical day people are inside their homes or, in the case of children in the colonia, inside schools. To gauge the level of penetration of brick kiln smoke into houses and schools, we placed small portable instruments (DustTrak Model 8520, TSI, Inc.) that use light scattering to indirectly measure PM10. We found two households, one in each colonia, who volunteered to have instruments in their houses. At the house in Mezquite II we also placed an outdoor PM10. At the school in Colonia Topahue in La Grullita, the two Directors (because of double sessions) also agreed enthusiastically to allow us to monitor inside one of the school buildings.

PM10 results of monitoring smoke using a laser-based instrument such as the DustTrak should only be considered to be semi-quantitative. No indirect method works well when PM levels are exceedingly high (200 to several thousand  $\mu\text{g}/\text{m}^3$  in this case). Our experience is that DustTraks tend to give low readings in heavy smoke aerosol when compared to a more direct method such as a TEOM (Thermo Fisher, Inc.). Therefore the high readings described below, while not completely accurate from a QA/QC point of view, are indicative of conditions that are hazardous to human health.

We began indoor monitoring 10/22/07 but did not have the outdoor monitor in place until 10/31/07. There is a two-week period when all of the instruments were in place and working properly and below are summaries of the results.

### **House in Colonia Topahue, La Grullita, 0.5 km from school.**

10/31-11/14/07 Average PM10 = 270  $\mu\text{g}/\text{m}^3$

(AQI = 158, Unhealthy)

(Maximum value was 10,900)

### **School in Colonia Topahue, La Grullita**

10/31-11/14 Average PM10 = 86  $\mu\text{g}/\text{m}^3$

(AQI Moderate)

(Maximum value was 1157)

### **House in Colonia Mezquite II.**

Outdoor monitor:

10/31-11/14/07 Average PM10 = 259  $\mu\text{g}/\text{m}^3$

(AQI = 153, Unhealthy)

Kitchen area indoor monitor:

10/31-11/14/07 Average PM10 = 228  $\mu\text{g}/\text{m}^3$

(AQI = 137, unhealthy for sensitive groups)

While the indoor average at the school was lower than in the nearby house, this appears to be heavily influenced by the school being tightly closed up when not in session. The following plot of 5-minute data from one day illustrates this point.

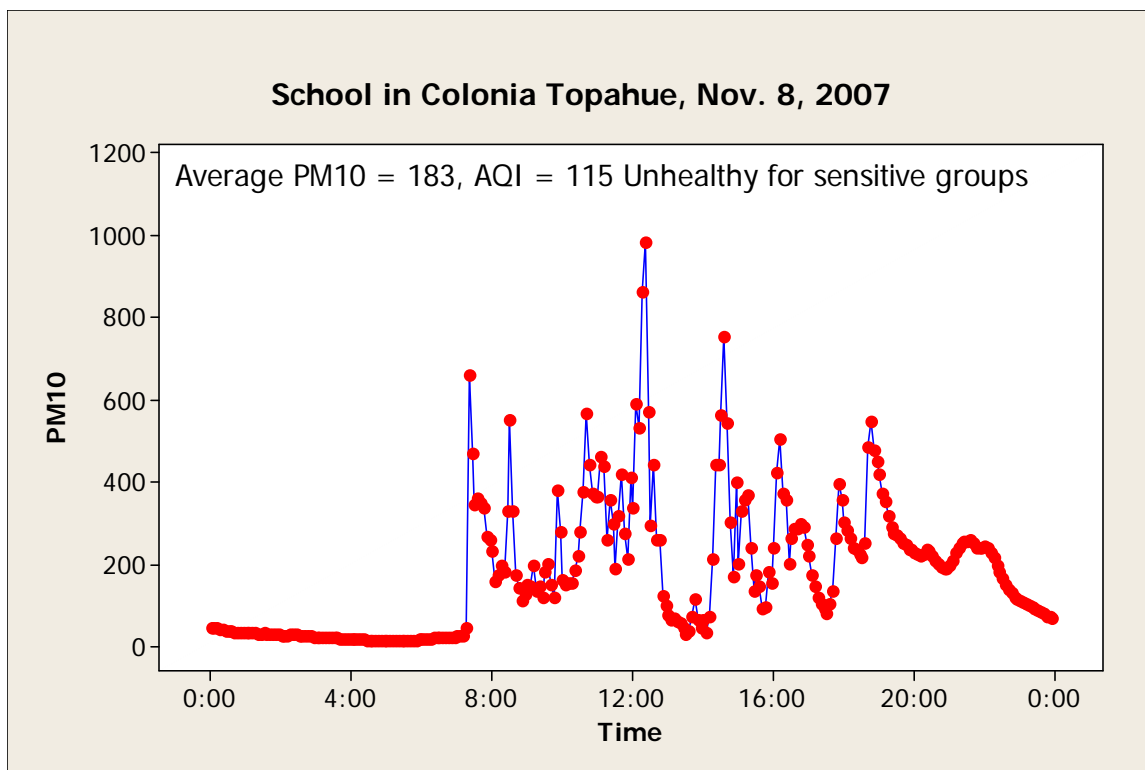


Fig. 3. PM10 5-minute data ( $\mu\text{g}/\text{m}^3$ ) from inside building at La Grullita School, Nov. 8, 2007 from midnight to midnight. School staff arrive and open up at about 7:30 AM each school day.

This contrasts with inside the nearby house that typically has some open windows at this time of year throughout the day (see Fig. 4). Also, apparently the house was closer to the source of smoke or more directly downwind of it.

The repeated indoor exposure to high PM10 levels is clearly a serious health issue in the brick-making colonias. A variety of medical studies indicate that the lung function of even healthy individuals is measurably reduced by exposure to such concentrations of smoke. A follow up study that evaluates the decrease in lung function in healthy children would be very useful to continue the efforts for convincing the brick-makers to relocate because of the significant leverage of concerns about the health of their children.

One of the issues of concern is that peak PM10 (and PM2.5, since we know from previous work that for the smoke PM2.5 can be as 70% or more of the PM10 level) can be several thousand  $\mu\text{g}/\text{m}^3$ . Very little is known about the long-term health effects of repeated exposure to short periods of such extreme concentrations.

See Figures 5,6, and 7 (end of report) for photos of DustTrak monitoring locations.

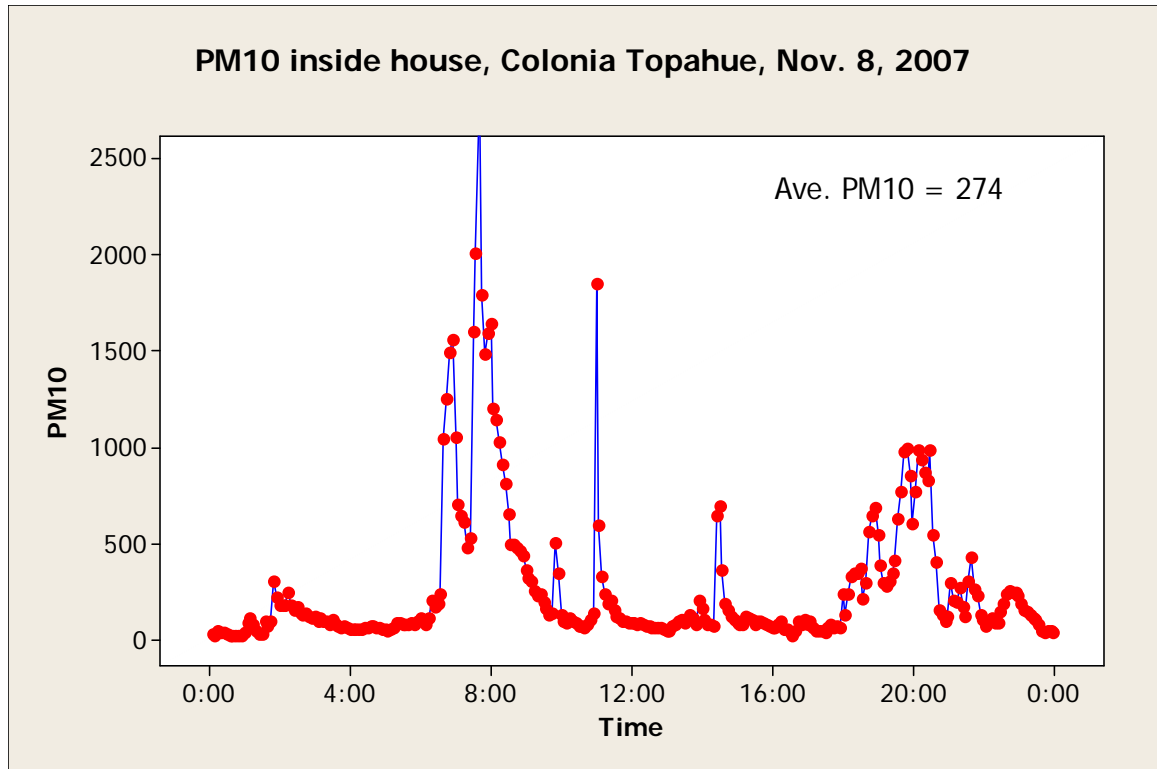


Figure 4. PM10 inside house, Colonia Topahue, November 8, 2007.

**Other Outreach: Presentations at binational meetings**

Presentations (20-60 minutes in length, including questions) about the study were made at the following binational meetings. The agendas and PowerPoint files are including in the additional files on the CD that accompanies this report except for the Aug. 22 meeting, which is appended to this document.

June 14, 2007 Arizona-Mexico Commission, Environment Committee. Held in Tucson, Arizona

Aug. 22, 2007 Arizona-Sonora Border 2012 Regional Workgroup, Ambos Nogales Air Quality Task Force. Held in Nogales, Arizona

Oct. 24, 2007 Binational Health and Environment Council of Yuma County, Arizona/San Luis R.C., Sonora. Held in Somerton, Arizona.

Jan. 23, 2008 Binational Health and Environment Council of Yuma County, Arizona/San Luis R.C., Sonora. Held in San Luis R.C., Sonora

Jan. 24, 2008 Arizona-Sonora Border 2012 Regional Workgroup, Ambos Nogales Air Quality Task Force. Held in Nogales, Sonora

### **Other Outreach: newspaper articles**

*La Cronica*, the daily newspaper in San Luis R.C. had as it's lead front page story on Feb. 16, 2008 an article about our work entitled "Respiran plomo por ladrilleras". Although there were a few errors in article (the work was incorrectly attributed to the University of Arizona and Western Arizona College), it effectively conveyed some of the health hazards of brick kiln smoke to a broad audience in San Luis R.C.

### **Issues with Relocation**

There are a number of issues with the relocation of brick-making operations to the city-owned site south of San Luis R.C. city limits. One key problem is that the relocated brick-makers are at economic disadvantage compared to those who do not relocate. More fuel is used to transport materials to the new site and finished bricks from the site to the customers. The city is unable to provide much in the way of assistance in building the infrastructure needed and some source of funding for infrastructure (on the order of perhaps \$20,000 US) would go far in facilitating the relocation. Another problem that we heard from spouses of brick-makers is that their husbands that work at the new location often spend the night there because of the distance and fuel costs and so the spouses feel unsafe at night. This then is a pressure to relocate residences to near the new site, which in turn would defeat the purpose of the relocation. A third problem is that the wastewater treatment plant near the new site has an open lagoon in which mosquitoes rapidly breed in warm weather. Previously very few people were working or living near this lagoon, but with the arrival of the brick-makers the mosquitoes represent a possible new health problem.

Although the traditional Sonoran bricks are a good building material with insulating properties far superior to modern but affordable alternatives like concrete block, in the long run a cleaner method of firing the bricks needs to be adopted or their production discontinued. Eventually the city limits of San Luis R.C. will reach the relocation site (encroachment is already evident and has clearly progressed in the several years that we have worked in the area) and at that point using the traditional kiln design and scrap fuel will be untenable.

### **Files on accompanying CD**

The accompanying CD has the following files:

1. Complete PM10 data from indoor monitoring
2. Agendas for 4 of the binational meetings at which presentation were made (one agenda available as a Word document is attached to this report)
3. PowerPoint files from the 5 presentations at binational meetings
4. The article that appeared in *La Cronica*

## Arizona-Sonora Border 2012 Regional Workgroup

### Ambos Nogales Air Quality Task Force Children's Environmental Health Task Force

#### Joint Meeting

August 22, 2007  
10:00 a.m. - 2:00 p.m.

Southeast Arizona Area Health Education Center (SEAHEC)  
1171 W. Target Range Rd.  
Nogales, Arizona

#### AGENDA

- |       |  |            |
|-------|--|------------|
| I.    | Welcome and Introductions  | 10:30 a.m. |
| II.   | Opening Remarks by Co-Chairs   | 10:45 a.m. |
|       | ▪ Ambos Nogales Air Quality Task Force   |            |
|       | ▪ Children's Environmental Health Task Force                                       |            |
| III.  | Presentation on Nogales Small-Scale Burning Assessment Study and Draft Action Plan | 11:00 a.m. |
| IV.   | Presentation on San Luis Brick Kiln Study Project                                  | 11:45 a.m. |
| V.    | Introduction of Integrated Pest Management Project                                 | 12:15 p.m. |
|       | Break  | 12:45 p.m. |
| VI.   | Progress Update on Ambos Nogales Biodiesel Capacity-Building Project               | 1:00 p.m.  |
| VII.  | Border 2012 Projects Selected for 2007   | 1:15 p.m.  |
| VIII. | Discussion of Future Collaboration and Projects                                    | 1:30 p.m.  |
| IX.   | Action Items   | 2:15 p.m.  |
| X.    | Adjournment  | 2:30 p.m.  |

*(The co-chairs reserve the right to adjust the agenda as necessary.)*



Figure 5. DustTrak PM10 monitor on cabinet in house in Colonia Topahue, La Grullita



Figure 6. House in Colonia Mezquite II with DustTrak monitors inside and outside. This was also the site of outdoor monitoring of active kiln operation during previous study (kiln was in foreground – the brick-maker has moved his operations to the new site south of the city limits).



Figure 7. School in La Grullita. Monitor was placed in Director's Office.-